

EXAMINATION OF INFORMATION SYSTEMS DEVELOPMENT
PROCESSES AND INDUSTRIAL ADAPTATIONS

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Thesis Abstract

Tuna Özçer, “Examination of Information Systems Development Processes and Industrial Adaptations”

This thesis examines current system development processes of three major Turkish banks in terms of compliance to internationally accepted system development and software engineering standards. After a deep scan on system development and software engineering standards, related process-based standards are selected and used to form a question list covering whole system development process that is ordered like classical Waterfall life cycle model. Each question in the checklist is made up of guidance and suggestions from the international system development standards. Later on, questions are interviewed with information technology departments of three major banks in Turkey. Results have been aggregated by examining current process status of three banks together and problematic points have been identified using international system development standards.

Tez Özeti

Tuna Özçer, “Bilgi Sistemleri Geliştirme Süreçlerinin ve Sektörel Uyarlamalarının İncelenmesi”

Bu tez, Türkiye’deki bankaların sistem geliştirme süreçlerindeki güncel durumunu, uluslararası kabul görmüş yazılım ve sistem geliştirme standartlarını kullanarak incelemeyi amaçlamaktadır. Çalışma öncelikle mevcut sistem geliştirme ve yazılım geliştirme standartlarını incelemekte, standartların detaylı incelenmesinden sonra süreçleri baz alan standartlar seçilerek bankaların süreçlerinde durum tesbiti yapmak için Çağlayan sistem geliştirme modeli aşamalarına göre sıralanmış bir süreç soru listesi oluşturulmaktadır. Soru listesinde yer alan her soru standartlarda yer alan süreç önerileri ve uyarılar baz alınarak oluşturulmuştur. Çalışmanın devamında oluşturulan sorular kullanılarak Türkiye’nin üç büyük bankası ile görüşmeler yapılmıştır. Görüşmelerden çıkan mevcut durumlar üç banka için standartlarda belirtilen ve beklenen durumlar ile birlikte değerlendirilerek üç bankanın süreç sorunları incelenmiş ve belirlenmiştir.

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ABBREVIATIONS

Abbreviation	Definition
ANSI	American National Standards Institute
ATM	Automated teller machine
BRSA	Banking Regulatory and Supervisory Agency
CMMI	Capability Maturity Model Integration
CoBit	Control Objectives for Information Related Technology
COSO	Committee of Sponsoring Organizations
COTS	Commercial-off-the-shelf
EIA	Electronic Industries Alliance
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
IT	Information Technology
ITIL	Information Technology Infrastructure Library
JTC1/SC7	ISO Joint Technical Committee 1/ Subcommittee 7
MOTS	Modified-off-the-shelf
PC	Personal computer
PMI	Project Management Institute
RAD	Rapid Application Development
RFI	Request for Information
RFP	Request for Proposal
S2ESC	IEEE Software and Systems Engineering Standards Committee
SCM	Software Configuration Management
SPICE	Software Process Improvement and Capability Determination
SRS	Software Requirements Specification
SW-CMM	Capability Maturity Model for Software
SWEBOK	Software Engineering Body of Knowledge
TCSE	IEEE Technical Council on Software Engineering
TSI	Turkish Standards Institute
XP	Extreme Programming

PREFACE

I believe that my thesis will be a reference for researchers on undiscovered area of process maturity and banking professionals to have a glimpse of their current status. In order to share my experiences I can say that most challenging part of such a thesis is convincing banks to work together due to their confidentiality policies and planning time in their busy working schedules.

Latest regulatory developments in Turkey in terms of auditing and best practices adopted by companies are indicators that industries where IT expenditures are high will keep on working with process frameworks such as Capability Maturity Model Integration (CMMI) and Control Objectives for Information Related Technology (CoBit) in order to reach to a certain process level. This work is crucial to gain a competitive advantage and reputation within the industry. Therefore, I believe that timing of this thesis is very proper with the nature of the industry and trends which makes me glad to be a portion of this interest.

CHAPTER ONE

INTRODUCTION

Business environment is becoming more technologically focused and current business processes heavily rely on information systems within industries. Complexity and increasing number of information systems enforce companies to establish processes to perform business functions on information systems and to operate in a more controlled environment.

In addition to the necessity of processes related to information systems, reports published by several companies indicate a high percentage of failure for information systems projects. CHAOS research performed by the Standish Group (1994) covering 365 companies, 8,380 applications and industries including banking, securities, manufacturing, retail, wholesale, health care, insurance, services, and local, state, and federal organizations found that:

- %16.2 of all software projects is completed on time and budget, with all functions and features as initially specified,
- %52.7 of the projects is completed, but over-budget, over the time estimate, and offers fewer features and functions than originally specified,
- Rest %31.1 of the software projects are cancelled at some point during the development life cycle.

Moreover, this research has focused on discovering why software projects fail and listed ten main reasons of project success:

- User Involvement
- Executive Management Support
- Clear Statement of Requirements
- Proper Planning
- Realistic Expectations
- Smaller Project Milestones
- Competent Staff
- Ownership
- Clear Vision & Objectives
- Hard-Working, Focused Staff

When these ten reasons of success are observed, it is obvious that most of the reasons are related to well-defined processes that reside somewhere in the system development process. Below are some discussions related to the success factors found by CHAOS research:

- User involvement in an information system development project is succeeded with several methods such as defining the system requirements together with the customer and gathering continuous feedbacks from the customer such as approvals and reviews during the process
- Executive management support can be ensured with assigning a business sponsor to a project and getting approval for the project kick-off, result of the feasibility study,

- Clear statement of requirements can be achieved by reviewing requirements definition documents and refining customer requirements,
- Proper planning, is related to planning each detail of a project such as resources, risks, scheduling and following up each plan in a timely manner throughout the process,
- Realistic expectations relate to validating customer requirements in terms of feasibility within the process,
- Smaller project milestones is an issue to be handled with project management plans and management of these plans during the process,
- Competent staff is affiliated with recruiting competent people and planning trainings for information systems projects within the process.

As mentioned in above discussions, it is obvious that most of the success factors related to the information systems projects are process-centric and organizational.

On the other hand, organizational complexity of banks in terms of Information Technology (IT) functions and system development efforts require well-established processes and proper execution of processes with predefined policies and procedures. Banking industry of today heavily relies on information systems for most of its functions. Due to increasing customers and transactions, banking is a major industry of concern with expanding organizational structure, intensive information systems expenditures.

It is illustrated that financial services that include banking have the highest Information Technology (IT) expenditures among industries in the world (Varlı, 2007). Figure 1 is a summary of IT expenditures by industries for the year 2006 where financial services that include banking industry have the highest investments among other industries in the world.

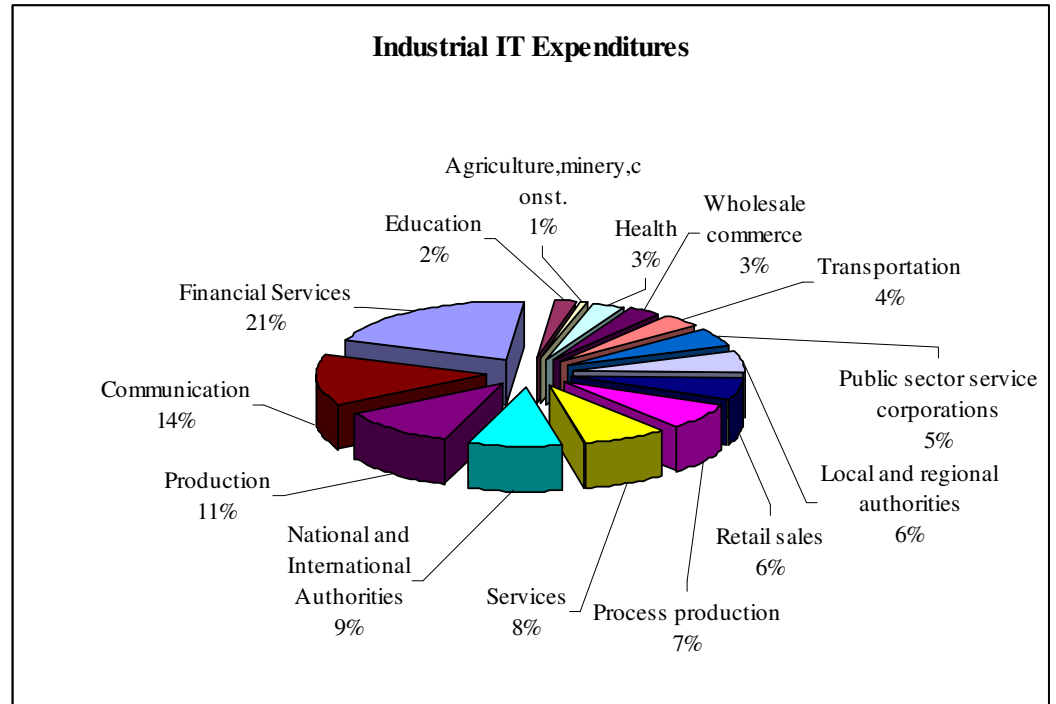


Figure 1: Industrial IT expenditures

As we move to the point of Turkish banks' IT expenditures we can see that numbers for the third quarter of 2007 is around 340 million YTL (Varlı, 2007). Figure 2 points out the fact related to the IT expenditures of Turkish banking industry.

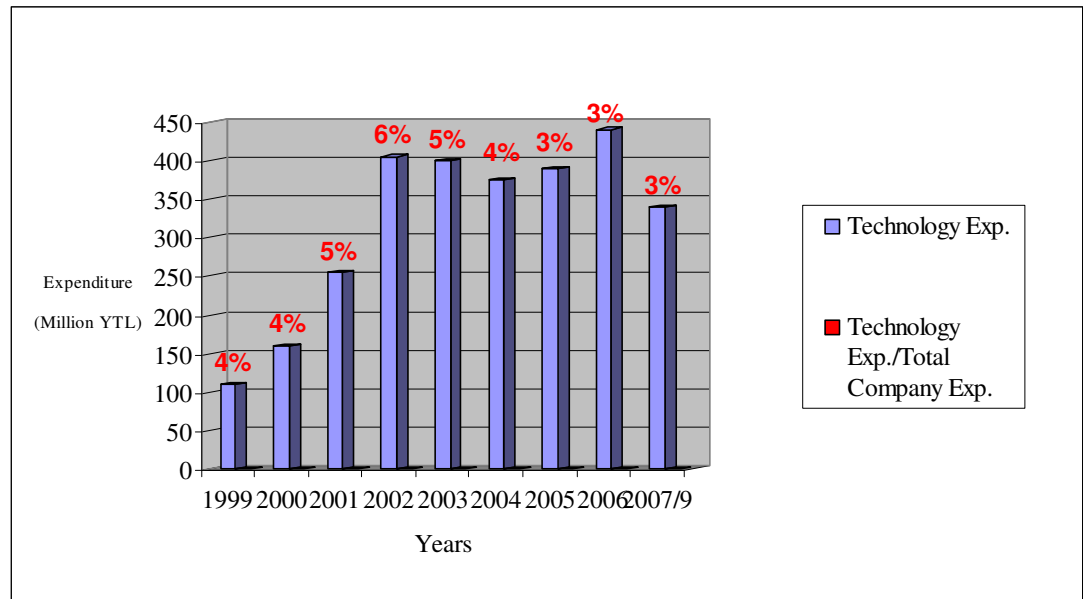


Figure 2: Turkish banking IT expenditures

Goal of the study

In the light of information given above such as information systems project success factors and industrial IT expenditures, the problem that this study will be touching is the examination of current system development processes in the banking industry using references such as international and process-centric system development and software engineering standards.

For this purpose, following research questions are discussed:

- According to the fact that being most spending industry on IT, are the banks managing information systems development processes compliant with the commonly accepted standards? What is the current status? What is the expected status?
- What is the gap between current and expected status? What is the problem that is caused by this gap?

- Do the banks have common problems related to the standards compliance at several stages of system development process?

CHAPTER TWO

LITERATURE REVIEW

System Development Standards

During the literature review phase several standards of different organizations have been explored in order to build structured questions that contain structured phases of system development from feasibility to post-implementation phases.

Standards of organizations like Institute of Electrical and Electronics Engineers (IEEE), International Organization for Standardization (ISO), American National Standards Institute (ANSI) have been searched for topics such as system development, software engineering, software development, system development life cycle and system development process. As a result of research, it has been found that organizations like IEEE use and adopt standards that have been created by ISO and International Electrotechnical Commission's (IEC) joint workgroup ISO/IEC JTC 1, Information technology, Subcommittee SC 7, Software engineering. However, it was noted that most of the IEEE standards refer to ISO standards in its documentation.

Relations of ISO, ANSI and IEEE

Legal entity relations summarize how IEEE, ISO and ANSI are linked to each other. As declared in ANSI's website (ANSI, 2007), ANSI is the sole U.S. representative and dues-paying member of ISO, and as a founding member of the ISO, ANSI plays an active role in its governance. Thus, standards set by ISO organization are all provided at the website of ANSI institute.

On the other hand, IEEE and ISO are closely linked organizations in standard activities. Most of the standards and projects under the direct responsibility of ISO Joint Technical Committee 1/ Subcommittee 7 (JTC 1/SC 7) are adopted by IEEE's Software Engineering Standards Committee. In addition to that, as declared in the website of ISO (ISO, 2007a), IEEE Computer Society is a liaison of ISO JTC 1/ SC7 technical committee. In the literature, if there is a related standard, IEEE standards give references to the standards of ISO and most of the IEEE standards declare that they can be used with ISO standards. Besides, IEEE develops its standards through a consensus development process, approved by ANSI, which brings together volunteers representing varied viewpoints and interests to achieve the final product.

Why are the standards important?

IEEE (2007a) lists out several benefits of standards and claims that access to and participation in standards provides:

- Market growth for new and emerging technologies
- Reduced development time and cost
- Sound engineering practices
- Decreased trading costs and lowered trade barriers
- Increased product quality and safety
- Reduced market risks
- Protection against obsolescence

On the other hand, Moore (1999) has discussed buyer and seller benefits of standards and claimed that standards can assist buyers and protect them by:

- Providing a vocabulary for communication between the buyer and seller,
- Providing objective criteria for otherwise vague claims regarding the product's nature,
- Defining methods for characterizing elusive characteristics, such as reliability,
- Assuring the seller that specific quality assurance practices were applied.

Moore (1999) also claims that benefits of standards for the buyers are underappreciated in the literature. He points out that standards are important, not because they represent the best practice, but because they

provide good enough practice. Moreover, courts generally view the application of standards as evidence that engineers perform their duties with diligence and responsibility.

Sources of Software Engineering Standards

Moore (1999) has listed organizations that publish worldwide software engineering related standards. He states that three organizations are generally regarded as the source of international standards:

- The International Organization for Standardization, ISO,
- The International Electrotechnical Commission, IEC,
- The International Telecommunications Union.

Two of those organizations cooperate in a Joint Technical Committee, ISO/IEC JTC1, responsible for information technology. A subcommittee, ISO/IEC JTC1/SC7, is responsible for standards related to software engineering and software systems engineering. SC7 manages a collection of about two dozen standards, the most popular being ISO/IEC 12207, Software Life Cycle Processes. Other technical committees and subcommittees of ISO and IEC make standards in related areas for example, ISO TC176 Quality Management, IEC TC56 Dependability, and IEC SC65A Functional Safety.

On the other hand, Moore (1999) points out that the Software Engineering Standards Committee of the IEEE Computer Society manages the world's most comprehensive collection of software engineering

standards (nearly 50), developed since 1979. IEEE Software Engineering Standards Committee (S2ESC) serves as a developer of these standards, but also as an integrator of specifications and standards developed by other organizations. It has adopted, sometimes with changes, standards developed by organizations such as ISO/IEC JTC1/SC7 and the Project Management Institute (PMI).

ISO

According to the information at ISO website (ISO,2007b), ISO is a network of the national standards institutes of 157 countries, on the basis of one member per country, with a Central Secretariat in Geneva, Switzerland that coordinates the system.

ISO is a non-governmental organization: its members are not, as is the case in the United Nations system, delegations of national governments. Nevertheless, ISO occupies a special position between the public and private sectors. This is because, on the one hand, many of its member institutes are part of the governmental structure of their countries, or are mandated by their government. On the other hand, other members have their roots uniquely in the private sector, having been set up by national partnerships of industry associations.

Therefore, ISO is able to act as a bridging organization in which a consensus can be reached on solutions that meet both the requirements of business and the broader needs of society, such as the needs of stakeholder groups like consumers and users.

IEEE

According to the facts on IEEE website (IEEE, 2007b), the IEEE, a non-profit organization, is the world's leading professional association for the advancement of technology. The full name of the IEEE is the Institute of Electrical and Electronics Engineers, Inc.

Through its global membership, the IEEE is a leading authority on areas ranging from aerospace systems, computers and telecommunications to biomedical engineering, electric power and consumer electronics among others. Members rely on the IEEE as a source of technical and professional information, resources and services. To foster an interest in the engineering profession, the IEEE also serves student members in colleges and universities around the world. Other important constituencies include prospective members and organizations that purchase IEEE products and participate in conferences or other IEEE programs.

Below are the quick facts related to IEEE (IEEE, 2007b):

- The IEEE has more than 370,000 members, including more than 80,000 students, in over 160 countries.
- 319 sections in ten geographic regions worldwide.
- 1676 chapters that unite local members with similar technical interests.
- More than 1526 student branches at colleges and universities in eighty countries.
- Thirty-nine societies and five technical councils representing the wide range of technical interests.

- 132 transactions, journals and magazines.

Usability of ISO/IEEE standards in Turkey

Software and system engineering related standards of ISO is developed by a subcommittee of a joint technical committee named JTC 1/SC7. Turkey is a participating country of this subcommittee by the standards organization Turkish Standards Institute (TSI). Below are the memberships of Turkey to Joint Technical Committee 1 and its subcommittees (ISO, 2007c):

- JTC 1 - Information technology (P-Member)
- JTC 1/SC 2 - Coded character sets (O-Member)
- JTC 1/SC 6 - Telecommunications and information exchange between systems (*O-Member*)
- JTC 1/SC 7 - Software and systems engineering (P-Member)
- JTC 1/SC 17 - Cards and personal identification (O-Member)
- JTC 1/SC 25 - Interconnection of information technology equipment (O-Member)
- JTC 1/SC 27 - IT Security techniques (O-Member)
- JTC 1/SC 29 - Coding of audio, picture, multimedia and hypermedia information (O-Member)
- JTC 1/SC 34 - Document description and processing languages (P-Member)

- JTC 1/SC 36 - Information technology for learning, education and training (O-Member)

Moreover, Turkey totally participates in 349 technical committees of ISO for several areas of expertise.

In the light of these facts, it can be summarized that ISO standards can be used thoroughly within the Information Technology industry of Turkey because Turkey is a participant of technical committees related to Software and Systems Engineering standards.

When it comes to IEEE, Turkey is not participating in the standards board or the standard setting activities for the standards created by IEEE Software and Systems Engineering and Software life Cycle Process workgroups. Turkey is a member of Region 8 committee of IEEE where Region 8 mainly works on membership development, technical activities such as conferences, educational activities and student activities (IEEE, 2007c).

However, Turkish Standards Institute (TSI) provides technical information services to researchers, third parties, industries including IEEE Standards. Information services include whole standards, draft standards and technical documents library (TSI, 2007).

All in all, participatory and information dissemination efforts of Turkish Standards Institute (TSI) shows that both ISO and IEEE standards can be adopted and used within Turkish Information Technology industry without restrictions.

ISO Standards

ISO has 103 active standards published by Software and Systems

Engineering Technical committee, JTC 1/SC7 (ISO, 2007d).

ISO has published standards on several dimensions of software engineering including:

- Information processing
- Special topics in Information Technology
- IT process assessment
- Software documentation
- Special topics in Software Engineering
- Software life cycle processes
- Software measurement
- Software product evaluation

During literature review for the standards it was observed that contents of ISO standards can only be viewed by payment at ISO website.

IEEE Standards

IEEE has forty-three active standards on the area of software engineering published by S2ESC and several organizations such as ISO, EIA, and IEEE Computer Society (IEEE, 2007d).

Standards published by S2ESC related to system development and software engineering is under software standards branch of information

technology standards. Major areas of concern in IEEE software engineering standards can be listed as follows:

- Software engineering terminology
- Software quality assurance
- Software configuration management
- Software testing and documentation
- System testing and documentation
- Software requirements specification
- Software unit testing
- Software verification and validation
- Software design description
- Software review
- Software anomalies
- Software metrics(quality and productivity)
- Software project management
- Software acquisition
- Software user documentation
- Software life cycle processes
- Software safety
- Functional modeling and conceptual modeling
- Software reuse
- System life cycle processes
- Web site engineering

IEEE Standard 1058 prescribes the format and content of software project management plans. Software Project Management plan is the document for managing a software project; it defines the technical and managerial processes and tasks necessary to develop software products that satisfy the product requirements. Moreover, it is stated in this standard that it may be applied to any type of software project. Use of this standard is not restricted by the size, complexity, or criticality of the software product. Standard is declared to be applicable to all forms of product delivery media, including traditional source code, firmware, embedded systems code, programmable logic arrays, and software-in silicon. Regarding the system development process it is given that this standard can be applied to any, or all, phases of a software product life cycle. (IEEE, 1998a)

IEEE Standard 1074, IEEE Standard for Developing a Software Project Life Cycle Process, is one of the standards that cover most stages of a classical system development process. According to the definition of the standard, this standard provides a process for creating a software project life cycle process and it is primarily for the use of process architect for a given software project. Methodology of the standard begins with the selection of an appropriate software project life cycle model for use on the specific project and it continues through the definition of the software project life cycle, using the selected software project life cycle model. Moreover, this standard defines the process by which a software project life cycle process is developed. As audience, this standard is useful to any organization that is responsible for managing and performing software projects. Hence, it can be

used where software is the total system or where software is part of a larger system (IEEE, 2006a).

IEEE Standard 1540 provides a process for the management of risk for several system development stages such as software acquisition, supply, development, operations, and maintenance. As the target audience it is aimed that both technical and managerial personnel throughout an organization apply this standard. It is given that purpose of the standard is to provide software suppliers, acquirers, developers, and managers a single set of process requirements suitable for the management of various risks. But, this standard does not provide risk management techniques, instead focuses on defining a process for risk management in which any of several techniques may be applied during the system development process (IEEE, 2001a).

IEEE Standard 1062 provides a recommended practice for software acquisitions where it describes a set of useful quality practices that can be selected and applied during one or more steps in a software acquisition process. This standard classifies software products according to the degree to which the acquirer may specify the features of the software. They are: commercial-of-the-shelf (COTS), modified-off-the-shelf (MOTS), and fully developed item. As the audience of the standard it is stated that this standard can be applied to software that runs on any computer system regardless of the size, complexity, or criticality of the software. However, this standard is given to be more suitable for use on MOTS software and fully developed software. (IEEE, 1998b)

IEEE Standard 1233 provides guidance for the development of software requirements that, when realized, will satisfy an expressed need. This standard also provides a process including several stages such as identification, organization, presentation, and modification of the requirements. Moreover, standard identifies characteristics of well-formed requirements and discusses properties of requirements (IEEE, 1998c).

IEEE Standard 830 provides a practice for writing software requirements specifications. Hence, this standard describes the content and qualities of a good software requirements specification and presents several sample outlines. On the other hand, target use of the standard has been stated as not only developed software, but also selection of in-house and commercial software products (IEEE, 1998d).

Umbrella standard ISO/IEC Standard 12207 provides a common framework for developing and managing software. In addition to that, IEEE/EIA standard 12207.0 consists of the clarifications, additions, and changes accepted by the Institute of Electrical and Electronics Engineers (IEEE) and the Electronic Industries Alliance (EIA) as formulated by a joint project of the two organizations. In other words, IEEE/EIA Standard 12207.0 contains concepts and guidelines to foster better understanding and application of the standard and it is one of the most detailed standards covering system development process. Thus, this standard provides industry a basis for software practices that would be usable for both national and international business (IEEE& EIA, 1996). IEEE/EIA Standard 12207 is packaged in three parts. The three parts are, briefly, as follows:

- IEEE/EIA 12207.0, Standard for Information Technology- Software life cycle processes: Contains ISO/IEC 12207 in its original form and six additional annexes: Basic concepts; Compliance; Life cycle process objectives; Life cycle data objectives; Relationships; and Errata. A unique IEEE/EIA foreword is included.
- IEEE/EIA Standard 12207.1, Guide for ISO/IEC 12207, standard for Information Technology- Software life cycle processes- Life cycle data: Provides additional guidance on recording life cycle data.
- IEEE/EIA Standard 12207.2, Guide for ISO/IEC 12207, Standard for Information Technology- Software life cycle processes- Implementation considerations: Provides additions, alternatives, and clarifications to the ISO/IEC 12207's life cycle processes as derived from U.S. practices.

IEEE& EIA (1996) have also listed several reasons indicating that IEEE/EIA Standard 12207.0 can be used to:

- Acquire, supply, develop, operate, and maintain software,
- Support the above functions in the form of quality assurance, configuration management, joint reviews, audits, verification, validation, problem resolution, and documentation.
- Manage and improve the organization's processes and personnel,

- Establish software management and engineering environments based upon the life cycle processes as adapted and tailored to serve business needs,
- Foster improved understanding between customers and vendors and among the parties involved in the life cycle of a software product.
- Facilitate world trade in software.

As mentioned beforehand, IEEE/EIA Standard 12207.2 is a standard based on the umbrella standard ISO/IEC 12207. ISO/IEC Standard 12207 provides a common framework for developing and managing software as a sequence of processes. IEEE/EIA standards based upon ISO/IEC Standard 12207 consist of the clarifications, additions, and changes accepted by IEEE and the Electronic Industries Association (EIA) as formulated by a joint project of the two organizations. So, IEEE/EIA standard 12207.2 provides implementation consideration guidance for the normative clauses of IEEE/EIA standard 12207.0. However, guidance is based on software industry experience with the life cycle processes presented in IEEE/EIA standard 12207.0. The guidance is intended to summarize the best practices of the software industry in the context of the process structure provided by ISO/IEC 12207 (IEEE& EIA, 1997).

IEEE (1998e) has defined software quality as the degree to which software possesses a desired combination of attributes in IEEE Standard 1061. Moreover, this standard underlines that desired combination of attributes should be clearly defined; otherwise, assessment of quality is left to intuition. According to IEEE Standard 1061(IEEE, 1998e), defining

software quality for a system is equivalent to defining a list of software quality attributes required for that system. In order to measure the software quality attributes, an appropriate set of software metrics should be identified. Finally, methodology defined in the standard is designed to allow organizations to:

- Achieve quality goals;
- Establish quality requirements for a system at its outset;
- Establish acceptance criteria and standards;
- Evaluate the level of quality achieved against the established requirements;
- Detect anomalies or point to potential problems in the system;
- Predict the level of quality that will be achieved in the future;
- Monitor changes in quality when software is modified;
- Assess the ease of change to the system during product evolution;
- Validate a metric set.

IEEE Standard 730 provides a reference to develop a software quality assurance plan. The purpose of the standard is to provide uniform, minimum acceptable requirements for preparation and content of software quality assurance plans (IEEE, 2002). But audience is also warned that outline of a software quality assurance plan provided within the standard is not a limitation that prevents further topics or sections in a software quality assurance plan.

IEEE Standard 1016 is a recommended practice which specifies the necessary information content and recommends an organization for software design descriptions (IEEE, 1998f). Standard intends to guide the production of anything from paper design documents to an automated database of design information. Moreover, for an organization in the process of developing a design description standard, it is claimed that use of this standard helps the new standard to meet the needs of all of organization's users. On the other hand, for an organization with a mature design description standard, this standard remains to be useful in evaluating and modifying that standard in light of the informational and organizational needs of the design description user community. As the target software of this standard, it is given that this standard can be applied to commercial, scientific, and military software. Applicability of it is not restricted by size, complexity, or criticality of the software. In addition to that, it is claimed that IEEE Standard 1061 can be used where software is the system or where software is part of a larger system that is characterized by hardware and software components and their interfaces.

IEEE Standard 828 provides minimum required contents of a Software Configuration Management (SCM) Plan. The SCM plan is a documentation of what SCM activities will be done, how they will be done, who is responsible for doing specific activities, when they are to happen, and what resources are required to execute the plan. This plan also addresses SCM activities over any portion of a software product's life cycle (IEEE, 2005).

IEEE Standard 829 aims to describe a set of basic software test documents. Hence, it specifies the form and content of individual test documents. But it does not specify the required set of test documents (IEEE, 1998g). This standard is claimed to be beneficial for use because a standardized test document can facilitate communication by providing a common frame of reference for groups involving in the testing process within a company.

IEEE Standard 1063 provides minimum requirements for the structure, information content, and format of user documentation. However, this standard is limited to the software documentation product and does not include the processes of developing or managing software user documentation (IEEE, 2001b). Usage area of this standard has been given as contracts or similar agreements when acquirer or supplier agrees that supplier will deliver documentation in accordance with the standard. Moreover, it is also possible to adopt this standard as an internal standard to be used by a project or organization.

ISO/IEC Standard 14764/ IEEE Standard 14764 describe management of the Maintenance Process described in ISO/IEC Standard 12207 in greater detail, including amendments. This international standard also provides definitions for various types of maintenance. Moreover, this standard provides guidance that applies to planning, execution and control, review and evaluation, and closure of the maintenance process (ISO& IEC& IEEE, 2006b). However, use of this standard is not restricted with size, complexity, criticality, or application of the software product. The criteria established by the standard apply to the planning of maintenance for

software under development, as well as the planning and execution of software maintenance activities for existing software.

IEEE Standard 1219 describes an iterative process for managing and executing software maintenance activities. As the target audience, it is stated that use of this standard is not restricted by size, complexity, criticality, or application of the software (IEEE, 1998h). In addition to that, IEEE Standard 1219 prescribes requirements for maintenance process and discusses control, management, execution, and documentation of software maintenance activities.

Finally, IEEE Standard 1028 provides definition of five software review types, together with procedures required for the execution of each review type (IEEE, 1997). Major point of concern in this standard is the reviews; it does not determine procedures for determining necessity of a review. So, this standard takes five reviews into consideration, namely management reviews, technical reviews, inspections, walk-through, and audits.

Related Organizations

Throughout the information gathering efforts for this study, several organizations have been found that are responsible of providing information and statistical facts related to banking industry.

Banking Regulatory and Supervisory Agency (BRSA)

First of all, Banking Regulatory and Supervisory Agency (BRSA) is a regulatory body in Turkey that regulates and supervises financial markets with following missions (BRSA, 2007a):

- To ensure confidence and stability in financial markets,
- To create an environment that will improve competitiveness of the financial system,
- To enable effective operating of loan system,
- To protect the rights and benefits of the depositors,
- To take necessary measures for enabling institutions subject to supervision to operate in a sound, secure and well-organized manner in market discipline.

Information systems and information technology aspects are taken seriously by BRSA which has several indicators. Firstly, BRSA publishes regulations for the information systems audits to be made in banks by independent audit institutions. Accordingly, independent auditing firms are performing yearly audits in the Turkish banks.

BRSA has started information systems audit efforts by the year 2004. Later, information systems audit team has been established and standards such as Control Objectives for Information Related Technology (CoBIT), BS7799, Information Technology Infrastructure Library (ITIL), Committee of Sponsoring Organizations (COSO), and FFIEC IT Examination Handbook have been examined by the audit team. Later on, Banking Information Technology Inventory Survey has been performed in

2005 to identify information technology utilization in Turkish banks and to create an IT inventory as a reference for further IT audits. Finally, Regulation on Information Systems Audit to be made in Banks by Independent Audit Institutions has been published by BRSA as a governing regulation of banking IT audits and CoBIT framework has been accepted as a reference framework to be used in the IT audits (Varlı, 2007). It is also claimed that CoBIT has been chosen because of its process audit focus and technology independence.

All in all, focus of BRSA on the audit of banking information systems processes using CoBit is an indicator that how seriously information systems development process should be taken by the banks currently and in the future.

The Banks Association of Turkey

The Banks Association of Turkey was founded in 1958 in accordance with the provisions of Article 57 of the Banks Act. The Association bears a legal entity and is the representative body for all the banks operating in Turkey. The purpose of the Association is to preserve the rights and benefits of banks, to carry on studies for the growth of the banking sector, for its robust functioning and the development of banking profession, strengthening of competition power, to take the decisions/ensure that they are taken to prevent unfair competition, to implement and demand implementation of these decisions, in line with the principles of open market economics and

perfect competition and the regulations, principles and rules of banking (The Banks Association of Turkey, 2008a).

Data Processing, Statistics and Technology Group of organization works to generate strategies about the association's data processing technology, to collect, verify and publish statistical data about the banking sector, to coordinate the projects that are common to the banking sector, and related to information technology, to follow up the developments on information technology.

In addition to all information provided above, the Banks Association of Turkey publishes researches, statistical reports related to financial facts of banks, branch and personnel information, information by regions and cities, and internet banking statistics (The Banks Association of Turkey, 2008b).

The Interbank Card Center

The Interbank Card Center was established in 1990 with the partnership of thirteen public and private Turkish banks for the purpose of providing solutions to the common problems and developing the rules and standards of credit and debit cards in Turkey, within the card payment system (Interbank Card Center, 2008).

The main activities of Interbank Card Center are carrying out the payment authorization operation between the banks, developing the procedures applicable to the banks in the credit card and debit card sector, forming the domestic rules and regulations, making efforts in relation to provision of standardization and taking the relevant decisions, establishing

relations with the international organizations and commissions and representing the members in these organizations when necessary and executing the ongoing bank operations from a single central operation site in a more secure, fast and cost-effective manner (Interbank Card Center, 2008).

System Development Methodologies

In order to carry out system development process, numerous methodologies exist in the literature with different approaches and limitations. Some of these methodologies are summarized and characteristics of each methodology are extracted from the literature in this chapter.

According to Huisman& Iivari (2006):

Systems development methodologies have been one of the most intensive topics in IS and Software Engineering research. Estimated number of methodologies is to be about 1000. Furthermore, organizations are facing pressure to use these methodologies. Despite the high investment in their development, their value is still a controversial issue. Recent surveys indicated that many organizations claim that they do not use any methodologies. Systems development is an activity involving and affecting many different stakeholder groups. Methodologies reflect their viewpoints and interests differently. Therefore, they perceive the benefits and problems of systems development methodologies differently.

Trying to define a systems development methodology is not easy. There is no universally accepted, rigorous, and concise definition of it. Some argue that the term methodology has no place in an IS, because, it literally means a science of methods. Others argue that the terms can be applied interchangeably. Others state that methodologies encompass methods, or, conversely, that methods encompass methodologies. Iivari and Maansaari discussed a number of conceptual problems related to the use of the term systems development method. They classified these problems into two types of inconsistency, scope and category problems. Avison and Fitzgerald argued that the term methodology is a wider concept than method, as it has certain characteristics that are not implied by method, the inclusion of a philosophical view. Therefore, for use here we define systems development methodology as a combination of the following:

Systems development approach: This involves the philosophical view on which the methodology is built. It is the set of goals, guiding principles and beliefs, fundamental concepts, and principles of the systems development process that drive interpretations and actions. Examples are the structured, object-oriented and information modeling approaches.

A systems development process model: A process model is a representation of the sequences of stages through which a system evolves. Some examples are the linear life-cycle model and the spiral model.

A systems development method: A method is a systematic way of conducting at least one complete phase of systems development, consisting of a set of guidelines, activities, techniques, and tools, based on a particular philosophy and the target system. Examples include OMT, IE.

A systems development technique: Development techniques can be defined as procedures, possibly with a prescribed notation, to perform a development activity, for example construction of entity relationship diagrams.

Waterfall Model

According to Gomaa & Kerschberg & Farrukh (2000), the earliest process model was a phased approach to software development referred to as the Waterfall Model. Tran & Liu (1997) stated that Waterfall model and its derivatives describe the software development process as an ordered sequence of engineering phases, ranging from requirement definition to operation. Moreover, each engineering phase has to be completed prior to the start of the subsequent phase in this model. This orderly process is illustrated with the forward pointing arrows. The backward pointing arrows capture the necessary reworks that are often experienced in software development projects. In the Waterfall model, these reworks are considered exceptions to the overall development process.

One another characteristic description for the Waterfall model has been given by Fruhling & Tyser & Vreede (2005), which indicates that this

model requires users to decide upon a set of requirements before beginning software engineering. The completion of each step produces documentation that is approved by the user. Approval of the documentation allows continuation of the project to the next step. The model also allows feedback and error correction.

Fioravanti (2006) has provided assumptions and detailed phase explanations of Waterfall model indicating that this model assumes that the process of software development can be divided in five phases to which two other phases (one before and one after) can be added to complete the cycle. Figure 3 provides a graphical representation of Waterfall life cycle and its stages.

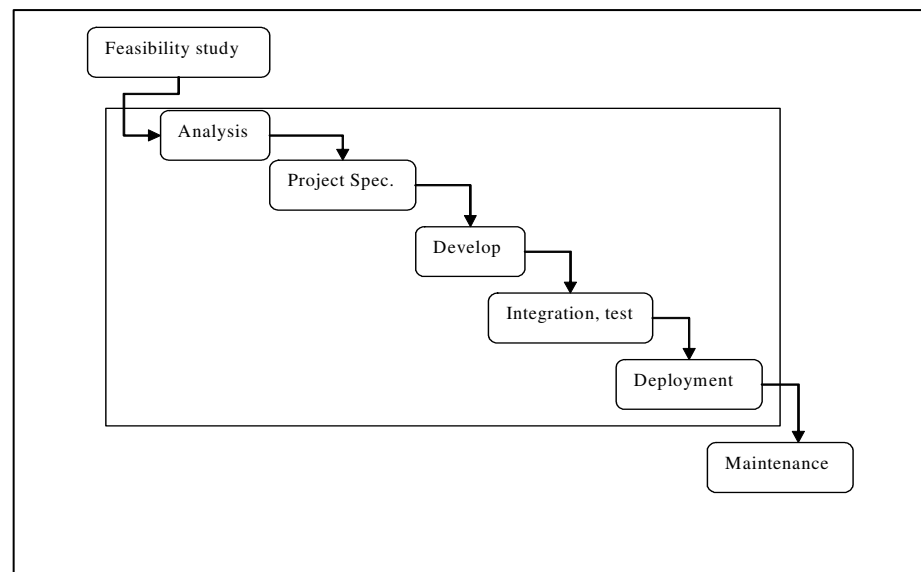


Figure 3: Waterfall model

In addition to the graphical flow of the model, Fioravanti (2006) has provided detailed definitions of six Waterfall model phases:

Feasibility study: The feasibility study can be defined as the make or buy phase, since company decides if a new project has to be realized, one or more products on the market have to be integrated, or if a product should be bought. The cost evaluation also has to be performed on this phase, since it can be the main reason that a company can discriminate between the make option or the buy option. The output of this phase is the feasibility document, in which the problem definition, scenarios of adoption, and costs and time for the different possible choices are reported.

Analysis: This phase is known as the real first phase of the project, since it is the first phase in which software system is realized. In this phase, complete analysis of the user problems is performed, and the functional requirements are drawn in detail.

Requirement specification document: This document contains the user requirements expressed as use cases in which the problem domain is analyzed in all its detail. This document can also assume the format of a user manual, in which the functionality is explained with the aid of some drawings of the user interface (if the system has a user interface). In practice, it is evidenced in this document what the application has to do.

System test plan: This document contains all the tests to be performed on the system in order to approve it with respect to the user requirements. The Waterfall life cycle requires that, before starting to write a single line of code and also before the choice of technologies and before the project of the system, all requirements must be established, and all tests to verify such requirements or use cases have to be defined in advance.

Project Specification (Design): This is the phase in which the requirement specification document objective is transformed into software architecture to be implemented in the development phase. This is the phase in which it's defined how to do what has been defined in the previous section. This phase is the core phase for the project manager, since his or her involvement is required more with respect to the other phases. In this phase, the software architecture, the technologies that have to be employed during project development, and the tools and languages to be adopted are defined. Sometimes, it is also necessary to define how the system interacts with other systems to be realized or already present, especially in the case of legacy systems to be integrated into the architecture. The project specification phase also extends to the deployment definition, since it is necessary to establish the hardware that has to support the hardware architecture. The last activity to be performed is the definition of the time line and the milestone for project verification. The result of this phase is the project specification document, in which all the previously analyzed aspects are detailed in order to have a clear guidance during the development phase.

Development: The development phase is the main phase of the project for its duration both in time and people months, since during this long phase, what has been analyzed and specified in the previous phases has to be coded and developed in practice. During this phase, several activities that are not only coding are usually performed. The project manager tracks project evolution against deadlines and project milestones. Developers have to document the written code and modules (usually performed by senior developers) with special attention to knowledge sharing and transmission.

The project also must be measured with software engineering metrics in order to have the possibility of verifying the quality aspects or for estimating the trend of some project figures, such as the effort spent versus the effort that was planned to spend, the comprehensibility and reusability of the project, and so forth. The output of this phase is the development of the code and the system, the code description document, and the actualized Gantt diagram and project measurement document that contains the metrics measured and estimated during project evolution.

Integration and test: The first part of this phase is to integrate different parts of the project in order to prepare the system for deployment in a test environment. The integration of the parts should be easy, if all the recommendations of the analysis and project specifications phases have been followed during the development phase. Unfortunately, this is often not the case, and some more development is needed in this phase. This is the way development and integration phases are partially superimposed. The second part of this phase is related to the test of the system. The system test usually is divided into two major phases: alpha test and beta test. The alpha test phase is an internal test of the system in the test deployment plan in order to verify compliance with respect to the system test plan. The beta test is partially superimposed to the deployment, since the system is released after the alpha test phase is installed in a deployment plant of some selected customers in order to verify the system behavior in conditions similar to the working status but not under the stress of a real working environment. During the beta test, usually several debug engines and libraries or logs are

maintained in the code in order to identify system parts to be corrected during the maintenance phase.

Deployment: This phase is also known as operation phase within the Waterfall model. In the deployment phase, the final system without the entire unnecessary debug tools are installed at the customer's site and systems is in operation for the use of customer.

Maintenance: The maintenance duration can be very long and can also finish when the system becomes obsolete and no longer used. The maintenance phase that usually follows the project completion is the so-called corrective maintenance, during which the errors discovered during the test phase are corrected and the system's successive minor versions are released and deployed at the customer's site. Other different maintenance activities can be planned, such as adaptive maintenance and preventive maintenance.

Olson (2004) has provided feedbacks of each stage in Waterfall model to minimize rework between stages. Each step reverts back to prior step if validation attempts uncover problems. Each stage involves a test, either validation or verification. Validation is the process of evaluating software to ensure compliance with specification requirements. (Is this right product?) Verification is the process of determining whether the software component functions correctly (Is the product built right?). Table 1 tabulates validation steps within the Waterfall model.

Table 1: Stages and Feedbacks of Waterfall Model

Stage	Feedback determinant
System feasibility	Validation
Software plans and requirements	Validation
Product design	Verification
Detailed design	Verification
Code	Unit test
Integration	Product verification
Implementation	System test
Operations and maintenance	Revalidation

As we move towards the limitations and drawbacks of the Waterfall model one approach identifies that this model is inadequate in reflecting the iterative and incremental nature of the modern software development process. Moreover, iterative and incremental developments are often needed to mitigate the risk the uncertainty that exists at the beginning of software projects (Tran& Liu, 1997).

Gomaa& Kerschberg& Farrukh (2000) have listed two problems and disadvantages that relate to the Waterfall model such as:

- Testing of software requirements: Software requirements are not properly tested until a working system is available to demonstrate to the end users in Waterfall model. These problems are compounded by the fact that changes in requirements to a delivered system are the most costly to correct during system development. They note that prototyping and operational specifications are two approaches that have been used to help address this problem. However, these approaches are only used to develop new systems and are less frequently used in software reuse.

- Difficulty in managing system evolution: In Waterfall model, requirements are assumed to be stable when they are actually dynamic and evolutionary. So, requirements specification may correctly reflect the user's needs at the time of its completion. However, when the system is delivered, evolutionary changes in the operational environment often result in the system no longer responding to user requirements. They note that incremental development approaches have been used to help address this problem.

In addition to above limitations and problems of Waterfall model Khalifa& Verner (2000) has underlined further limitations of Waterfall Model:

- System requirements are frozen before the design begins in Waterfall model. For some projects, however, the users do not know the requirements beforehand.
- Hardware technology is chosen early in the development process as part of the requirements specification phase. Given the speed with which hardware technology is evolving, large projects that take a few years to complete may end up with hardware specifications that are on the danger of becoming obsolete.
- The process is document driven in Waterfall model. Heavy documentation is not practical, and sometimes not suitable, for interactive applications where developing elaborate documentation of the user interface is not feasible.

- Waterfall model does not allow for iterative enhancements, as system requirements must be completely specified before the design can start.

Fruhling & Tyser & Vreede (2005) point out problems related to Waterfall model as requiring early commitment from the users in the development stages and its inflexibility when software requirements change during the process.

On the other hand, Olson (2004) defines advantages of Waterfall model as follows:

- Encouraging planning before design
- Decomposing system development into sub goals with milestones corresponding to completion of intermediate products. He notes that this allows project managers to more accurately track progress of the project and it provides project structure.

One another aspect of Waterfall model is to which kind of projects this model can be applied. McConnell (1996) points out that the Waterfall model works well for projects that have a stable product definition and well-understood technical methodologies, and it works especially well if the project staff is inexperienced since it provides the project with a structure that helps to minimize wasted effort. In addition to that, Khalifa & Verner (2000) state that the Waterfall method is rather suited for routine types of projects where the requirements are well defined along the process.

Iterative, incremental delivery paradigm which is not allowed by Waterfall Model describes a class of systems delivery methods that

concentrates on techniques that produce manageable pieces of a system iteratively, and deliver functionality incrementally. Duggan& Reichgelt (2006) have provided a list of production methods allowing iterative/incremental delivery, such as:

- The spiral model, which combines the sequential development philosophy of the Waterfall model and prototyping to deliver software in an evolutionary development approach that “grows” software in several rounds (or iterations) by “spiraling” repeatedly through a sequence of IS delivery activities.
- Rapid application development (RAD), which involves high user-developer interaction to produce systems expeditiously (time boxing) by fixing development time and varying scope and quality.
- Cleanroom software engineering (CSE), which seeks to generate defect free IS with statistically certified reliability by employing independent specification, development, and certification teams,
- Agile development methods: Extreme Programming (XP), Adaptive Software Development, Feature Driven Development, Crystal Clear Method, Dynamic Systems Development Method (DSDM), Scrum, and others which depend on intense user-developer interaction to expedite software delivery by producing small pieces of functionality, namely releases, at regular intervals.

Spiral Model

According to Tran & Liu (1997), Spiral model and its derivatives; attempt to address some inherent limitations of the Waterfall model. This model embodies the approach analyze a little, design a little and implement a little as the part of software development process. This model's iterative and incremental dynamics provide a framework for modern object oriented development methodologies. In addition to that, Fruhling & Tyser & Vreede (2005) claim that Spiral Model has been proposed to address shortcomings of the Waterfall Model such as inflexibility and long development time.

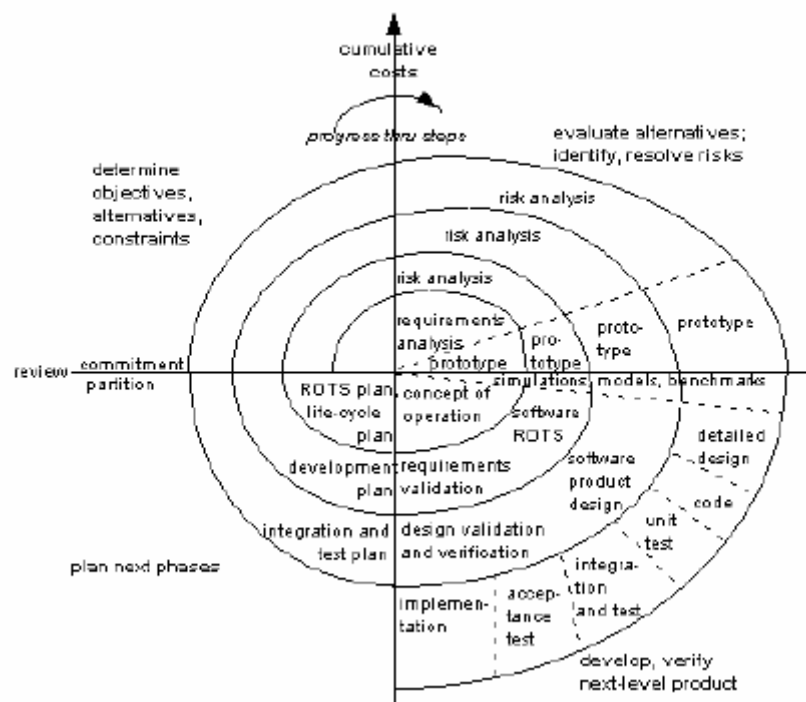


Figure 4: Spiral model

Fruhling & Tyser & Vreede (2005) have also provided detailed phase explanations of this model as following:

1. Objective Setting: System objectives, alternatives, and constraints are determined and a detailed management plan is created for development in this phase. Besides, risks related to the project are identified and addressed including alternatives based on risks.
2. Risk Assessment: Risk identification is performed and the appropriate risk prevention steps are taken in this phase. Example implementations can be listed prototyping, simulation, and benchmarking.
3. Development and verification: Risks identified in the risk assessment phase, aid in determining which development model to use in this phase. For example, if business workflow is of concern, a simulated system may be appropriate.
4. Planning: A decision is made as to whether the project will continue on to another loop of the spiral in which case, the four sections will repeat and plans are created for the next phase.

Olson (2004) has provided a more risk-centric definition to Spiral Model. Olson points out that Spiral Model uses iterative prototypes and for each portion of the system a risk analysis is performed. Starting with a concept of systems operation, a requirements plan is developed. Software requirements are generated and validated, followed by a development plan.

Risk analysis is repeated, and a new prototype incorporating the new development plan is generated, followed by software product design, which is validated, verified, integrated and tested. After another risk analysis, an improved prototype is developed with a more detailed design. With this more complete information, coding proceeds, along with testing, integration, acceptance testing and implementation. Olson (2004) has also tabulated cycles of Spiral Model as given in below Table 2.

Table 2: Cycles of Spiral Model

Cycle1	Cycle2	Cycle3	Cycle4
Risk Analysis	Risk Analysis	Risk Analysis	Risk Analysis
Prototype	Prototype models	Prototype models	Operational prototype models
Operation concept A	Software requirements	Software product design	Detailed design
Requirements plan s	Requirements validation	Design validation and verification	Code Unit test
Life-cycle plan w	Development plan	Integration and test plan	Integration and test Acceptance test Implementation

As we shift to the advantages of Spiral Model Fruhling & Tyser & Vreede (2005) have provided items such as: (1) More flexibility for changing requirements, (2) Risk assessment at each loop or prototype, (3) Underestimation of a risk assessment in a project can lead to increased cost and schedule overruns. Moreover, Yamamichi & Ozeki & Yokochi & Tanaka (1996) state that this model is useful in the sense it confirms and evaluates

quality, performance and the scale of the software at the early stages of development.

On the other hand, disadvantages of Spiral model are being development centric, failing to reflect procurement-centric nature of the component-based software engineering process (Tran& Liu, 1997), existence of a need for some clarity such as more clearly defining longer term objectives and plans (Fruhling & Tyser& Vreede, 2005).

In terms of the project types that Spiral Model can be applied to, Fioravanti (2006) claims that this model can support projects with a lower stability in requirements.

Agile Software Development

The Agile Manifesto (Agile Alliance, 2001) has been published by Agile Alliance. The main assumption stated in that manifesto is:

Through this work we have come to value:

- Individuals and interactions over processes and tools,
- Working software over comprehensive documentation
- Customer collaboration over contract negotiation, and
- Responding to change over following a plan.

Fruhling & Tyser& Vreede (2005) have described four key ideas of Agile software development as follows:

Individuals and interactions over processes and tools, argues that there is too much emphasis placed on coding and development tools.

Instead, team members and their communication with each other have a much larger role in the successful completion of a project.

Working software over comprehensive documentation, states that though software documentation is an important piece of development, the more effective tool is the code itself and training through human interaction.

Customer collaboration over contract negotiation is based on the fact that successful software development requires frequent communication between the user and the developer.

Responding to change over following a plan, addresses the problem that long-term plans created for projects are not easily allowing for changes; whereas, short-term plans provide more flexibility in responding to changes. So, a better approach is to devise a detailed plan for a two week period and a general plan for a three month time period.

Fairley& Willshire (2005) point out an advantage that result of products when agile models are used rate high in customer satisfaction and have low defect levels.

Extreme Programming

One of the more prominent processes that adhere to the principles of Agile development is Extreme Programming. The extreme programming embodies iterative development, working in frequently with the customer, and producing small and frequent releases. Below figure (Figure 5) illustrates the process of Extreme Programming (Fruhling & Tyser& Vreede, 2005).

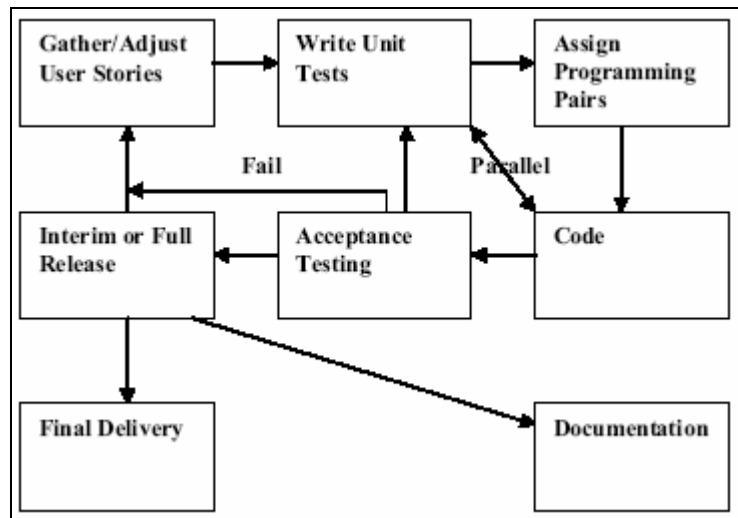


Figure 5: Extreme Programming model

Fruhling & Tyser & Vreede (2005) have also provided below steps in the Extreme Programming process:

In the first step, user stories are gathered to represent system requirements.

Then, users and developers determine which requirements will be developed in the next iteration of the process.

Next, test plans are written prior to coding. Unit tests writing and coding are done in parallel corresponding to a particular unit of system development.

Programming pairs are assigned to specific tasks.

As a unit of the system is developed, an acceptance test is performed by the user.

If acceptance test fails, the user and developer will meet again to adjust the user stories and the process will repeat itself from the scratch.

A passing acceptance test will continue on to an interim release for individual units or a full release for a complete system.

Following the final release, documentation is completed and a final delivery of the system is made to the users.

Finally Fruhling& Tyser& Vreede (2005) have discussed advantages and disadvantages of Extreme Programming and have provided following table (Table 3).

Table 3: Advantages and Disadvantages of Extreme Programming

Advantages	Disadvantages
Quick prototype production	Scalability issues
Iterative process	Over focusing on early results
Frequent feedback from user	Pair programming is not cost effective
Encourage design experimentation	Test- driven approach adds development time
Increased system reliability	Lack of specific requirements to ensure user satisfaction
Refactoring	Unstructured
High code production	Unpredictable
Quality code	Neglected planning
Team ownership of code	Required experienced developers
Cohesive developer environment	Access to committed users
Flexibility	Lack of documentation
Lower overhead	Higher overhead
More effective on small to medium size projects	Not effective on large projects

Quick prototype production advantage of Extreme Programming is related to the practice of small and frequent releasing mechanism in Extreme Programming. Besides, iterative process means enhancing the product by small releases and continuous feedbacks from the customers. Extreme programming encourages design experimentation as it allows a

continuous and simple design which is closely affiliated with the constant and quick feedback from the users. According to the fact that unit tests are developed before actual code is written, it increases confidence in system reliability. Moreover, refactoring, which is a technique used to improve code without altering functionality and its goal is to produce programming units with a strong internal structure, aids developers in faster responding to changing requirements. Pair programming approach in Extreme Programming has proven to produce higher quality code at a lower cost. Due to collective ownership practice, code is owned by the whole team where anyone can make changes at anytime. Flexibility of this model lies within its repetitive and shorter cycles for prototyping.

Although Extreme Programming has many beneficial aspects, it is also believed to have some drawbacks. Firstly, Extreme Programming is difficult to scale up to large projects because this model lacks sufficient architecture planning and focuses on early results. Use of pair programming doubles the development personnel cost and its test-driven approach requires higher development efforts to adapt and run test cases. Due to the fact that requirements can change any time and non-existing specific requirements, it is harder to guarantee customer satisfaction. It is given that many managers view this model dangerous and unpredictable because it neglects planning and controlling requirement of large scale projects. Finally, documentation process which is executed after reaching to the full release causes lack of sufficient documentation.

Regarding the project types that Extreme Programming can be applied to Finally Fruhling & Tyser& Vreede (2005) point out that this

model is hard to apply to large scale projects due to its lack of architecture planning and over-focusing on early results.

Prototyping Life Cycle

Olson (2004) defines prototyping as the process of developing small working model of a program component or system with the intent of seeing what it can accomplish. So, it is actually a learning device, which is appropriate when users are not sure about their requirements. He also states that prototyping approach involves building a small-scale mockup system, allowing the user to try the system. The user could then ask for modifications. Moreover, prototyping is much less thoroughly planned approach, but it is often appropriate for applications with low investment and low structure.

Fioravanti (2006) underlines two types of prototypes in the literature: Throw-away prototype and it is typically adopted in a rapid application development (RAD), in which the user interface has a great relevance in the project. This prototype is simply eliminated, once the user interface and the main functionalities have been validated and approved. He states that this process is not a real life cycle, since it is only one phase after which the result is used for the real project.

Second prototyping life cycle is a real life cycle which is suitable mostly for user interface-intensive applications, where the feedback that can be obtained from the user in front of a prototype can be very useful.

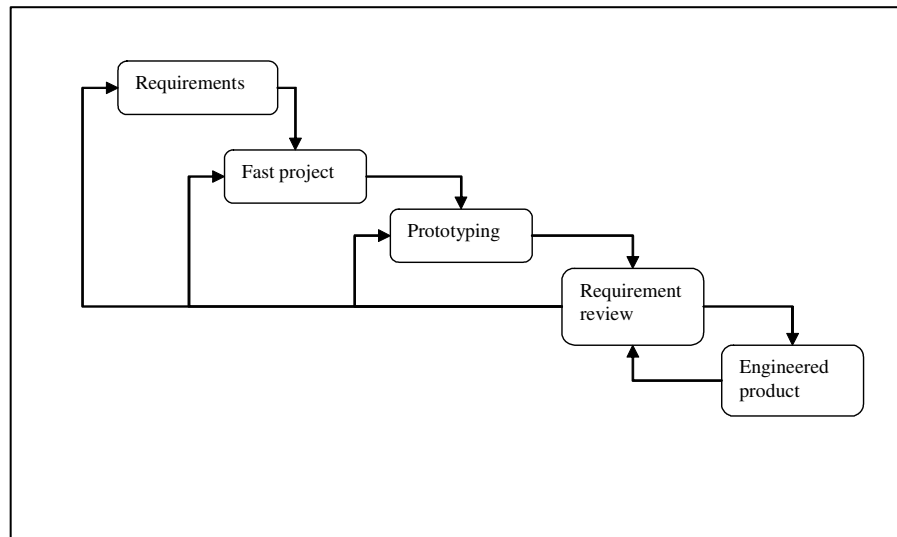


Figure 6: Prototyping life cycle

Fioravanti (2006) has also provided detailed phase explanations of Prototyping Life Cycle Model. According to that explanation Prototyping Life Cycle is composed of two main iterative processes. The very first iteration is for the requirements (fast project, prototyping and requirement review), while the second is between requirement review and engineered product phases. During the first phase, from general requirements and a fast project phase, system prototype is prepared. In front of the working prototype, requirements are reviewed, and an engineered product starts to exist, if requirement review results are positive. Otherwise, cycle jumps back to one of the preceding phases, generating improved working prototype and so forth. Process stops only when the engineered product is compliant with all the user requirements, precisely when the prototype has become a product. This life cycle is closest to Agile development and Extreme Programming (XP) among the classical life cycles.

Although there are numerous international studies related to usage of ISO, IEEE and ANSI standards, during literature review for existing bibliography, following academical studies on the subject have been identified for Turkey:

- Kalaycı (1995) has performed a software process assessment of Turkish software industry by discussing software maturity models such as Capability Maturity Model Integration (CMMI), Bootstrap, Trillium, Software Technology Diagnostic, Software Process Improvement and Capability Determination (SPICE). This study has classified major sectors as package programs, service, special projects, and military projects and firms have been identified to perform the assessment according to the major sectors. Process assessment has been performed using a questionnaire extracted from CMM maturity model at four software firms. Although, study carries out the same logical path and similar type of questions, this study does not conclude with a problem list resulting from the CMMI model.
- Tarhan (1998) has applied ESI Software Best Practice Questionnaire to thirty software-developing organizations in Turkey and compared the results with the implementations of the same questionnaire to European countries by European Union. Study performs the assessment in the dimensions of software process maturity and software best practices. This study has a common issue with our study such as covering

financial and insurance sector companies. But, this study has put an emphasis on quantitative assessment by calculating maturity levels and best practices of the organizations and comparing the results with the European assessment performed in 1995 to compare adoption levels of organizations by sectors.

CHAPTER THREE

METHODOLOGY

By speaking of methodology, we mean the way that our study has been carried out with subsequent phases.

First issue of this study has been finding the relevant system development and software engineering standards that build up the system development process questions. While selecting the standards to use for the questions preparation, following criteria has been used:

- Correspondence to a stage of classical Waterfall model:
Standard has been selected if it corresponds to one of Waterfall life cycle phases such as feasibility, analysis, design, coding, testing, implementation, maintenance, review. Definitions of Waterfall model stages provided in the literature have been used for this purpose.
- Being process-centric: Standards that discusses process based issues rather than technical issues and have been preferred.
Moreover, standards which have built an input, output mechanism between sections and processes to be performed have been chosen in this phase.
- Accessibility: If there is a standard published by ISO and adopted by IEEE, accessible standard has been used for question generation.

For the planning of the research IEEE standards have been selected to form the system development process questions. First reason for this choice is relation of IEEE Standards to ISO standards by being a liaison of ISO JTC1/ SC7. Secondly, IEEE Standards are easily accessible through IEEEExplore which is the official research portal of IEEE. However, ISO standards' adopted versions can be found on IEEEExplore, but ISO standards are reachable only by payment at ISO's website. IEEE Standards have also been preferred for discussing more detailed system development process issues than ISO.

According to above criteria, forty-three active IEEE software engineering and system development standard have been scanned by reading at this stage in order to use in the preparation of system development process questions. As a result seventeen out of forty-three standards have been selected and used to form the system development questions. Please refer to Appendix A for the list of IEEE standards used for question generation and Appendix B for the list of IEEE standards that are not used while preparation of questions.

While selecting the standards it was noted that, standards that has shown the highest correspondence to stages of system development process, namely IEEE Standard 1074, IEEE Standard 12207.0, and IEEE Standard 12207.2 have shown process sequence similarity to classical Waterfall life cycle model. Due to this fact, questions have been grouped according to the stages of classical Waterfall life cycle model. Each question has been generated with respect to the guidance or process definitions that have been provided by selected IEEE Standards. As a result, 151 questions for the

whole system development process have been generated in question preparation phase (Please refer to Appendix C for the representation of question list).

According to BRSA monthly bulletin, there are currently twelve active domestic private banks in Turkey (BRSA, 2007b). On the other hand, BRSA (2006) has provided a ranking of existing domestic private banks as of 2006, including seventeen banks, according to their assets in the descending order as follows:

Table 4: Ranking of Private Domestic Banks by Total Assets

Bank	Total Assets (x 1000 YTL)	Percentage in Total Assets of all banks
Bank 1	63,712,468	%16
Bank 2	52,384,532	%13.2
Bank 3	36,468,239	%9.2
Bank 4	23,866,400	%6
Bank 5	14,791,941	%3.7
Bank 6	12,314,144	%3.1
Bank7	9,357,809	%2.4

Bank 4 and Bank 5 in this table have had a merger in 2006. So, three domestic private banks interviewed in this study are selected from top six domestic private banks that have the highest assets in 2006.

After the decision that questions have matured sufficiently, interviews have been performed with three major Turkish banks by asking the questions to banking professionals who are versed on process practices. Due to the complexity of the process and the questions, questions have been divided according to the area of expertise within the banks. Each work at the bank included profiles such as:

- Project manager,

- Software designer/ developer,
- Business/system analyst,
- Risk management professional,
- Quality assurance professional.

In addition to that, time, date and subject of each interview have been recorded in interview log documents.

Due to corporate confidentiality requirements of banks, a confidentiality agreement has been signed and sealed by the advisor of the thesis stating that gathered information will only be used for academic purposes and will not be shared with third parties was given to the banks prior to starting interviews.

Finally, having completed interviews with all banks and gathered current process situations, banks' current situation is compared with expected situations that come from the standards. While doing this, objectives that are mentioned at the Questions and the Standards section are used at this stage. Current situation of three banks have been compared to the standards and if exists, a problem definition has been created for questions.

CHAPTER FOUR

QUESTIONS

Questions and the Standards

This section has been dedicated to establish the relation between IEEE standards related to system development processes and questions.

Nevertheless, correspondence of phrases, guidelines and processes in IEEE standards and their mapping to questions is explained in this section question by question.

System development process has been divided into ten phases with inspiration from the Waterfall system development life cycle model and most detailed standards IEEE Standard 1074, IEEE Standard 12207.0 and IEEE Standard 12207.2. Further than the phases of system development, question list has been arranged starting with general questions related to project management and system development. Later, during scanning IEEE standards related to system development, suggestions for related phases of system development have been placed to the corresponding phase. As a result, 151 questions have been created in order to assess the whole system development process. Please refer to Appendix C for complete question list.

Outline of the system development questions and question numbers are as follows:

- Project Management in general (Questions 1-20)

- Characteristics of projects being managed in the company
- Plans generated for project management
- Risk management approach of the company
- System Development in general (Questions 21-23)
 - System development frameworks or best practices adopted by the company
 - System development or project management methodology of the company
- Feasibility (Questions 24- 27)
 - Dimensions of feasibility performed by the company
 - Approval of feasibility study
- Analysis& Requirements Definition (Questions 28-48)
 - Identification of requirements by the company
 - Classification of requirements
 - Approval of requirement analysis
 - Software requirement specification (SRS) documentation
 - Functional description of the system
 - Approval of software requirements specification
 - System quality requirements
- Design (Questions 49-57)
 - Software Quality Assurance plan
 - Software Design Description documents
 - Architectural design

- Detailed design
- Approval of design descriptions
- Coding/ Package Selection (Questions 58-85)
 - Software development plans
 - Coding standards
 - Code review process
 - Software packaging
 - Software configuration management plan
 - Software configuration management policy and procedure of the company
 - Release management plan of the company
 - Versioning standards
 - Access to software libraries
 - Monitoring process for contractors
 - Software acquisition process
 - Request for Proposal
 - Supplier evaluation and selection
 - Software development documentation
 - Unit testing
 - Integration testing and planning
 - User documentation
- Testing (Questions 86-101)
 - Testing policies and procedures of the company
 - Integration testing
 - Software transfer between environments

- Acceptance test planning
- Test design and test case specification
- Test summary reporting
- User acceptance testing and approval
- Implementation (Questions 102- 112)
 - Migration to production
 - Operation of production environment
 - System monitoring
 - Problem related policies and procedures of the company
 - Problem ticketing for system implementation
 - Company's helpdesk practice
 - Software user documentation
 - Documentation procedures of the company
- Maintenance (Questions 113- 136)
 - Procedures related to system problems and problem ticketing
 - Maintenance plans
 - Maintenance process of the company
 - Maintenance requests
 - Feasibility and analysis of maintenance requests
 - Maintenance implementation plan
 - Maintenance approval
 - Testing for the maintenance and modification

- Documentation changes resulting from the maintenance
- Design changes resulting from the maintenance
- Regression/Unit/Acceptance/System testing resulting from the maintenance
- User training resulting from the maintenance
- Approval of maintenance for satisfactory completion
- Review (Questions 137-151)
 - Review policies for technical and management reviews
 - Review procedures for technical and management reviews
 - Scope of management reviews
 - Scope of technical reviews
 - Software quality metrics of the company
 - System quality objective of the company
 - Definition of software quality
 - Inspection of software products
 - Walk-through for the software products
 - Post-implementation review

During the preparation of system development process questions, seventeen standards of IEEE have been used for several phases of system development out of forty-three active software engineering standards. IEEE standards have been read to create related questions to phases of a structured

system development. Below standards have been used while forming the questions:

- IEEE Standard 1074- Software life cycle processes
- IEEE Standard 1540- Software life cycle processes risk management
- IEEE Standard 1062- Software acquisition
- IEEE Standard 1058- Software project management plans
- IEEE Standard 1233- Developing system requirements specifications
- IEEE Standard 830- Software requirements specification
- IEEE/EIA Standard 12207.2- Software life cycle processes implementation
- IEEE/EIA Standard 12207.0- Software life cycle processes
- IEEE Standard 1061- Software quality metrics
- IEEE Standard 730- Software quality assurance
- IEEE Standard 1016- Software design description
- IEEE Standard 828- Software configuration management
- IEEE Standard 829- Software testing and documentation
- IEEE Standard 1063- Software user documentation
- ISO/IEC Standard 14764 - IEEE Standard 14764 - Software life cycle processes and maintenance
- IEEE Standard 1219- Software maintenance
- IEEE Standard 1028- Software reviews

Please refer to Appendix A and Appendix B where detailed reasoning for using or not using these standards is provided.

Mapping questions to IEEE standards

In this section, preparation of each question is discussed by giving the related part of the related IEEE standard. Actually, a basis for creating each question is given in detail. Moreover, objectives that are used when identifying the situation and problems of the companies are shared with the audience. Objective part that resides in each question is actually a logical explanation regarding the reason of asking each question. Although most of the questions relate and refer to a specific standard, there are some informational questions solely asked to gather information about the company without referring to a standard.

1. Standard: This question does not adhere to a specific IEEE standard.

1. Objective: This question aims to have a general opinion about the scale of the projects managed by the company. During examination of answers this question will be used to give introductory information about the company.

1. Question: What are the characteristics of the projects being managed in terms of scale?

2. Standard: This question does not adhere to a specific IEEE standard.

2. Objective: This question aims to have a general opinion about the budget and requirements of the projects managed by the company.

Throughout the examination of answers, this question will be used to give introductory information about the projects of the company.

2. Question: What are the characteristics of the projects being managed in terms of budget and requirements?

3. Standard: IEEE Standard 1058's fourth section, Elements of the software project management plan, lists down all the managerial process plans that should be created by the organization that manages the software project. Moreover, standard indicates that the organization managing the project is also responsible for the software management plan (IEEE, 1998a).

3. Objective: This question has been asked to check compliance with IEEE Standard 1058. Furthermore, question checks if several types of project management plans (Estimation, staffing, staff training, work activities, resource allocation, budget allocation, requirements control plan, schedule control plan, budget control plan, quality control plan, reporting plan, risk management plan, close-out plan) are created by the company.

3. Question: Are software project management plans created for the software projects?

4. Standard: IEEE Standard 1058's Evolution of Plans section explains that as project plans get more detailed during the project's life cycle they should be maintained under configuration management with versions (IEEE, 1998a).

4. Objective: This question is asked to check compliance with IEEE Standard 1058. Besides, question aims to check if project management plans are maintained and retained through the project life cycle as defined in the standard.

4. Question: How is the project management plan maintained through the life cycle of the project?

5. Standard: IEEE Standard 1058's Control Plan section describes what sub elements of control plan should be created when managing a software project. Standard indicates that metrics, reporting mechanisms, and control procedures necessary to measure, report, and control the product requirements, the project schedule, budget, and resources, and the quality of work processes and work products should be specified within the plan (IEEE, 1998a).

5. Objective: This question provides elements of a project control plan and aims to find out which of these elements provided by IEEE Standard 1058 are created and controlled by the organization.

5. Question: Is a project control plan created? Which of the following are specified within the plan?

6. Standard: IEEE Standard 1074's required Manage Project sub-process suggests that progress of the project should be reviewed and measured against the established and estimated plans (IEEE, 2006a).

6. Objective: This question has been asked to check compliance with IEEE Standard 1074. Moreover, question has been designed to evaluate if the interviewed company makes a measurement between estimated plans and actual results.

6. Question: Is the progress of the project reviewed and measured in terms of estimated and actual plans?

7. Standard: IEEE Standard 1058's Managerial Process Plan section includes a Risk Management plan subsection. Risk management plan's

objective, usage, necessity and utilization during project life cycle are explained in the standard (IEEE, 1998a).

7. Objective: Firstly, this question has been asked to check compliance with IEEE Standard 1058. Company's approach to risk management is learned whether it is performed through a plan or not, throughout the project life cycle.

7. Question: Is there a risk management plan within the software project plan for identifying, analyzing, and prioritizing project risk factors?

8. Standard: IEEE Standard 1058 has a clause dedicated to technical process plans. This section makes a suggestion regarding what should be included in technical process planning for a software project. Standard suggests that a technical process plan including development process model, the technical methods, tools, and techniques to be used to develop the various work products should exist for a system development project (IEEE, 1998a).

8. Objective: Firstly, this question is asked to check compliance to IEEE Standard 1058. Further than that, question assesses whether company creates required components of the technical process plan.

8. Question: Is there technical process plan created in the software project plan?

9. Standard: IEEE Standard 1058 has a dedicated subsection for Subcontractor Management Plans. Related section defines what should be included in the plan and how the plan should be utilized during the project life cycle. Standard suggests that requirements management, monitoring of technical progress, schedule and budget control, product acceptance criteria,

and risk management procedures should be included in each subcontractor plan (IEEE, 1998a).

9. Objective: First of all, this question is asked to check compliance to IEEE Standard 1058. In addition to that, question assesses existence of subcontractor management plans if partial stages of system development are outsourced by the company.

9. Question: Is subcontractor management plan created in the software project plan for selecting and managing any subcontractors that may contribute work products to the software project?

10. Standard: IEEE Standard 1058's Subcontractor Management Plan subsection indicates that subcontractor selection criteria should be defined within the subcontractor management plan (IEEE, 1998a).

10. Objective: Having assessed the existence of subcontractor management plan (if required), this question is asked to check if subcontractor management plan created by the company includes subcontractor selection criteria.

10. Question: Are criteria for selecting subcontractors specified in the subcontractor management plan?

11. Standard: IEEE Standard 1074's Project Management Section of Activity Groups main process has a sub processes called Plan Training and Plan documentation. These required sub processes suggest that training plan and documentation plans should be created at the software project's planning phase (IEEE, 2006a).

11. Objective: This question assesses if documentation and training plans, which are required by the standard, are created at any phase of the projects being managed at the company.

11. Question: Are documentation and training plans created for system development projects?

12. Standard: IEEE Standard 1074's Project Management Section of Activity Groups main process has a sub processes called Retain Records. Retain records sub process suggests that project records should be collected from activity groups and used for future project planning by the organizations (IEEE, 2006a).

12. Objective: Firstly, this question has been asked to check compliance with IEEE Standard 1074 in terms of project close-out and retaining project records. Furthermore, question aims to find out organizational practice for keeping historical records of past projects.

12. Question: Are project records collected and retained from all activity groups at the close-out?

13. Standard: IEEE Standard 1540 has a sub process named Establish Risk Management Policies. Process suggests that risk management policy should be explicitly defined and provides what the policies should contain in order to perform an effective risk management for system development projects. Moreover, standard indicates that there should be a defined process for risk management that is governed with risk management policies (IEEE, 2001a).

13. Objective: Main objective of the question is to check compliance to IEEE Standard 1540. In addition to that, question checks if the

company's risk management process is governed by a clearly documented risk management policy and procedures in accordance with the policy.

13. Question: Has the company defined risk management policies/procedures for system development projects?

14. Standard: IEEE Standard 1540 has a sub process named Establish the Risk Management Process. Process suggests that risk management process should be documented and promulgated (IEEE, 2001a). Furthermore, process defines what a risk management procedure consistent with the process should include related to risks including:

- The frequency at which risks are to be reanalyzed and monitored,
- The type of risk analysis required (quantitative and/or qualitative),
- The scales to be used to estimate risk likelihood and consequences and their descriptive and measurement uncertainty,
- The types of risk thresholds to be used,
- The types of measures used to track and monitor the state of the risks,
- How risks are to be prioritized for treatment,
- Which stakeholder(s) perspectives the risk management process supports,
- The risk categories to be considered.

14. Objective: Firstly, main objective of the question is to check compliance to IEEE Standard 1540. Moreover, question aims to have

detailed information about the company's procedures related to risk management. Thus, company's risk management procedure is assessed with respect to IEEE Standard 1540.

14. Question: Which aspects of the risk management process are created and documented?

15. Standard: IEEE Standard 1540 has a sub process called Establish Risk Thresholds. Standard first provides a definition of risk threshold and suggests that risk thresholds should be defined for individual risks or combination of risks in system development projects. Furthermore, standard addresses measures to indicate risk accession should be set and documented in the risk state (IEEE, 2001a).

15. Objective: First of all, this question aims to verify compliance with IEEE Standard 1540. On the other hand, question checks if company sets risk thresholds is to measure risks with consistent measures in the risk management context.

15. Question: Does the company define risk thresholds for the projects? For what aspects thresholds are set by the company?

16. Standard: IEEE Standard 1540 has a sub process called Establish and Maintain Project Risk Profile. This sub process suggests that for each project a project risk profile should be established and maintained to be used throughout the project life cycle (IEEE, 2001a). Moreover, standard lists minimum components of a project risk profile as following:

- The risk management context
- A chronological record of each risk's state including their likelihoods, consequences, and risk thresholds

- The priority ordering of each risk based on criteria supplied by the stakeholders
- The risk action requests for risks along with the status of their treatment.

16. Objective: First objective of the question is to check compliance to IEEE Standard 1540. In addition to that, minimum components of the project risk profile are asked to the companies and compatibility to the standard is further verified for the companies.

16. Question: Does the company create risk profile for the projects?

17. Standard: IEEE Standard 1540 has a sub process called Communicate Risk Status. This sub process emphasizes that project's risk profile should be periodically communicated to project's stakeholders based upon their requirements (IEEE, 2001a).

17. Objective: First aim of the question is to check compliance to IEEE Standard 1540. Another objective of the question is to verify if the project's risk profile is communicated to stakeholders in a periodical manner.

17. Question: At which frequency project's risk profile or relevant risk profile (e.g., a single or combination of risks) communicated to stakeholders?

18. Standard: IEEE Standard 1540's Perform Risk Analysis section emphasizes that system development project's risks should be analyzed in the sequence of identification, estimation and evaluation phases. Standard suggests a continuous risk analysis throughout the software life cycle and states that various techniques such as risk questionnaires, taxonomies,

brainstorming, scenario analysis, lessons learned, and prototyping can be used to identify the risks (IEEE, 2001a). Later on, in the risk estimation phase, the likelihood of occurrence and consequences of each risk identified shall be estimated. Finally, standard suggests that each risk should be evaluated against its risk thresholds. Risks should be evaluated independently, in combination, and along with their interactions with system and enterprise risks. Risks should be evaluated against the project risk threshold to assure that a combination of risks, while below their individual thresholds, does not unacceptably place the project as a whole at risk.

18. Objective: First of all, question checks compliance to IEEE Standard 1540. On the other hand, company's approach, methods and process for risk analysis is learned with the question.

18. Question: Does the company perform risk analysis throughout the system development life cycle to identify, estimate and evaluate risks? How are the risks evaluated at the end? What are the evaluation parameters?

19. Standard: IEEE Standard 1540 has a dedicated sub process for risk monitoring, namely Perform Risk Monitoring. Process suggests that risks and risk treatment should be continuously monitored and recorded in the risk profile (IEEE, 2001a). Moreover, standard guides that this method will enable seeking out new risks. Furthermore, standard emphasizes that results of risk monitoring should be reported to project stakeholders.

19. Objective: Question's first objective is to verify compliance to IEEE Standard 1540. In addition to the very first objective, question checks if the company performs risk monitoring, risk recording and communication of risks to the project stakeholders.

19. Question: Does the company monitor risks for changes in their state using measures? Is the monitoring recorded in the project risk profile? Who is responsible of risk monitoring? Is reporting performed after monitoring process?

20. Standard: IEEE Standard 1540 has a dedicated sub process for evaluation of risk management process which is named Evaluate the Risk Management Process. This sub process suggests that whole process for risk management should be examined for its efficiency and deficiencies (IEEE, 2001a). Standard lists out purposes of evaluation to provide feedback stakeholders regarding:

- The quality of the risk management process
- Areas where the risk management procedures, process, or policies should be improved
- The identification of opportunities for modifying organizational risk management procedures, processes, or policies to better reduce or eliminate systemic risks.

20. Objective: This question firstly checks compliance to IEEE Standard 1540 in terms of risk management process evaluation. Later on, it checks whether risk management process is subject to an evaluation to measure its efficiency and to improve the process and generate lessons learned.

20. Question: How does the company evaluate its risk management process? Who performs the evaluation of risk management process?

21. Standard: This question does not refer to a specific standard.

21. Objective: Objective of the question is to learn if the organization uses a process management or best practice framework for IT Governance. Due to regulations set by the Banking Regulation and Supervision Agency (BRSA), banks are audited with some IT Governance frameworks. Beyond this fact, a bank can implement another process capability or best practice framework.

21. Question: Is there a system development process management framework used by the company? (ITIL, CoBIT, CMM)

22. Standard: This question does not refer to a specific standard.

22. Objective: This question aims to perform an analysis using literature review performed on system development methodologies. Due to the literature review, it was found that some methodologies are more suitable for some type of requirements and projects. So, this question will result in an analysis between company's software requirement types, system development methodology and project characteristics.

22. Question: Is there a system development methodology used in the organization?

23. Standard: This question does not refer to a specific standard.

23. Objective: An underlying reason for information systems success is a tailored methodology. Due to this reason, this question checks whether the company has tailored a known system development methodology or not for system development projects.

23. Question: Has the company tailored the system development methodology?

24. Standard: This question refers to IEEE Standard 1062

Recommended Practice for Software Acquisition. IEEE Standard 1062 has a process called Planning Organizational Strategy which suggests that an organization should first plan software acquisition and then turn the planning into an organizational software acquisition strategy (IEEE, 1998b). Moreover, standard suggests that strategy should include:

- List of capabilities to identify potential suppliers,
- Identification of responsibilities of acquirer and the supplier,
- Extent of supplier's organizational involvement to provide the quality product,
- Identification of responsibilities that are best handled by the acquirer's organization,
- Identification of responsibilities to include in the contract and to be negotiated with the supplier.

24. Objective: Firstly, this question checks compliance with IEEE Std. 1062. Secondly, question verifies existence of an organizational strategy for acquiring packaged products.

24. Question: Does the company have a software acquisition strategy for acquiring off-the-shelf products?

25. Standard: IEEE standard 1074 has a sub process called Conduct Feasibility Studies. This sub process suggests that an analysis of idea or need should be performed which includes potential approaches and all life time benefits of the need. Furthermore, sub process suggests that feasibility study can also be used to make the make or buy decision (IEEE, 2006a). 25.

25. Objective: First of all, this question is asked to verify compliance

with IEEE Standard 1074. Secondly, question checks if the company performs a feasibility study to identify alternative courses of action at the project outset.

25. Question: Is feasibility study conducted at the beginning of the system development project? Who is the responsible unit of the feasibility study?

26. Standard: IEEE standard 1074 has a sub process called Conduct Feasibility Studies. This sub process suggests that an analysis of idea or need should be performed which includes potential approaches and all life time benefits of the need. Furthermore, sub process suggests that feasibility study can also be used to make the make or buy decision (IEEE, 2006a).

26. Objective: Having assessed compliance with IEEE Standard 1074 this question aims to learn the method of the company while performing the feasibility study. So, a list of possible feasibility methods such as cost, user, and operational feasibility are provided to the respondents.

26. Question: What are the dimensions of feasibility study? What are the methods of feasibility study? How does the company make the go decision?

27. Standard: This question refers to IEEE Standard 1074. This standard's sub process named Conduct Feasibility Studies suggests that each recommended practice in the feasibility study should formally be approved by concerned organizations such as user and the developer (IEEE, 2006a).

27. Objective: Further than assessing compliance with IEEE Standard 1074 this question checks if results of the feasibility study are formally approved by related parties in the organization.

27. Question: Who approves the result of feasibility study?

28. Standard: IEEE Standard 1233 has a section for identifying system requirements. This section identifies techniques for identifying requirements and highlights interaction between customer and the analysts (IEEE, 1998c). Standard provides several methods and approaches to define requirements. It is mentioned that whole process can be undertaken by the customer, while customer interacts with the analysts for assistance in another approach. In addition to that, standard provides several techniques to identify requirements such as workshops, brainstorming sessions, interviews, surveys, and questionnaires.

28. Objective: This question firstly checks compliance to IEEE Standard 1233. Moreover, it aims to find out if roles that participate in identification of system requirements are one of the given practices in the standard. Moreover, technique used by the company to identify system requirements is inquired with this question.

28. Question: How does the company identify requirements?

29. Standard: This question has been asked in accordance with IEEE Standard 830. IEEE Standard 830 indicates that Software Requirements Specification document may be written by one or more representatives of the supplier (an organizational unit or an outsourced firm), one or more representatives of the customer. Standard suggests joint preparation of software requirements specifications (IEEE, 1998d).

29. Objective: As stated in IEEE Standard 830 this question tries to gather information about parties that participate in definition of business requirements further than supplier and the customer. However, if there is no extra participant than supplier and customer, it will not be concluded as non compliance to IEEE Standard 830. As joint preparation of requirements is strongly suggested, only evaluation is based on preparation of requirements together.

29. Question: Are business sponsors and IT project leads involved in defining business requirements?

30. Standard: This question refers to the standard IEEE/EIA standard 12207.2. This standard has a process called Development Process and first sub process of Development Process is Process Implementation. Process implementation suggests that developer of the system should select a software life cycle model appropriate to the scope, magnitude and complexity of the project (IEEE& EIA, 1997).

30. Objective: This question does not measure compliance to the standard IEEE/EIA 12207.2. As a known fact, most of the companies have a defined system development life cycle. However, aim of the question is to force respondents to make a self-evaluation for the appropriateness of the system development life cycle used within the organization compared to characteristics of the projects.

30. Question: Does the company select a software life cycle model appropriate to the scope, magnitude, and complexity of the projects?

31. Standard: This question refers to IEEE Standard 1074. IEEE Standard 1074 defines set of activities for developing software project life

cycle processes. Project Initiation Activity Group of the standard has a sub process called Define Metrics which suggests that project metrics should be created with respect to project requirements and project plans. Moreover, standard underlines that project metrics can be related to quality, process or productivity and target of the metrics to be applied are given as products of the project and the processes that affect the project (IEEE, 2006a).

31. Objective: Firstly, this question checks compliance with IEEE Standard 1074. Furthermore, it verifies if the company creates metrics for the projects in the initiation phase related to quality, process and productivity to apply on products and project processes.

31. Question: Are project metrics created for the project with respect to the project requirements, project management plan?

32. Standard: This question refers to the standard IEEE/EIA 12207.0. This standard divides system development process into five primary processes one of which is Acquisition Process. Acquisition Process begins with definition of need to acquire a system and continues with preparation of request for proposal. Acquisition process's initiation sub process suggests that if a supplier is retained to perform requirement analysis, the acquirer should approve analyzed requirements (IEEE& EIA, 1996).

32. Objective: This question checks compliance to the standard IEEE/EIA 12207.0 in terms of approval of analyzed requirements by the supplier.

32. Question: How does the company approve the analyzed requirements if software requirements analysis is performed by a supplier? Who approves the analysis?

33. Standard: This question refers to IEEE Standard 830 which provides a recommended practice for software requirements specifications. This standard identifies basic issues that a software requirements specification document should address such as:

- Functionality: What is the software supposed to do?
 - External interfaces: How does the software interact with people, the system's hardware, other hardware, and other software?
 - Performance: What is the speed, availability, response time, recovery time of various software functions?
 - Attributes: What is the portability, correctness, maintainability, security considerations?
 - Design constraints: Are there any required standards in effect, implementation language, and policies for database integrity, resource limits, and operating environments?
- (IEEE, 1998d).

33. Objective: This question firstly checks compliance to IEEE Standard 830. Moreover, this question tries to check if the software requirements specification documents created by the company cover minimum aspects of an expected document.

33. Question: Are software requirements specification documents prepared?

34. Standard: According to IEEE Standard 1233, customer is an entity, target audience of system requirement specification process and process for developing system requirement specifications include customer feedbacks. Standard suggests that after presenting the requirements, it should be updated with respect to the feedbacks from the customer (IEEE, 1998c). Customer feedback consists of updating customer objectives, problems or needs. Below figure (Figure 7) illustrates the requirement definition process provided by IEEE Standard 1233.

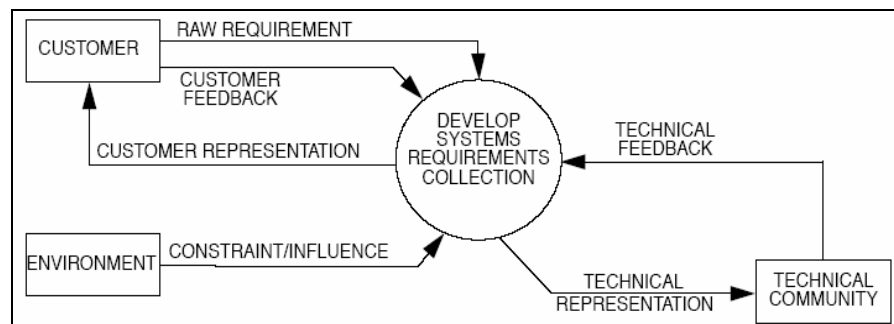


Figure 7: Requirements development process

34. Objective: This question firstly checks compliance to IEEE Standard 1233. Later on, it checks whether system requirement specifications are presented to the customer and updated according to the feedbacks from the customers.

34. Question: Does the company get customer feedbacks during preparation of system requirement specifications to update requirements and customer's problems? Who follows up the requirements that are triggered by the customers?

35. Standard: IEEE Standard 1233 defines a process for system requirements specification. Technical community is expected to be placed somewhere in the process to provide feedback. Standard suggests that to discover changes related to system requirement specifications earlier, technical community should be included to the early stages of the process (IEEE, 1998c).

35. Objective: This question aims to check compliance to IEEE Standard 1233 in the beginning. It also verifies if a technical community is included in system requirements specification process to discover new requirements earlier and to eliminate changes to the original requirements.

35. Question: Is the technical community included in the requirements specification phase? What is the gain that technical community brings out to the phase?

36. Standard: IEEE Standard 1233 suggests categorization of requirements on different dimensions and requirement and provides a list of possible classification aspects as following (IEEE, 1998c):

- Identification: Each requirement should be uniquely identified.
- Priority. The customer should identify the priority of each requirement.
- Criticality. The analyst, working with the customer, should define the criticality of each requirement.
- Feasibility. The customer and analyst working together should identify the feasibility of including each particular requirement in the system

- Risk. Risk analysis techniques can be used to determine a grading for system requirements.
- Source. Each requirement should be further classified by a label that indicates the originator.
- Type. Requirements can also be categorized by one or more of the following types:
 - Input
 - Output
 - Reliability
 - Availability
 - Maintainability
 - Performance
 - Accessibility
 - Environmental conditions
 - Ergonomic
 - Safety
 - Security

36. Objective: This question first checks compliance to IEEE Standard 1233 in the issue of classifying customer requirements. Moreover, it aims to understand in which dimensions customer requirements are classified by the company.

36. Question: Are customer requirements classified?

37. Standard: IEEE standard 1233 defines a process for System Requirement Specification process. In the first phase, namely Identify Requirements, requirements are identified with customers, technical

communities. In addition to that, standard suggests that requirements should be validated during identification of requirements (IEEE, 1998c).

37. Objective: This question firstly checks compliance to IEEE Standard 1233. It also aims to check if requirement set identified with the customer and technical community is subject to a validation by the company.

37. Question: Does the company validate requirements to be designed from the set of requirements that customers demand? If yes please specify how?

38. Standard: IEEE Standard 830 indicates that software requirement specification document may need to evolve as the development of software progresses. Moreover, standard suggests that there should be a formal change process to track and control changes (IEEE, 1998d).

38. Objective: This question firstly checks compliance to IEEE Standard 830 and it also aims to find out if the company follows a formal change process on system requirement specification documents.

38. Question: How are the changes occurring during the project reflected to Software requirements specification (SRS) documents? Is there a formal change process for changing requirements which allows retaining up-to-date SRS documents?

39. Standard: Although it is not a mandatory issue in requirements definition, IEEE Standard 830 defines prototyping useful for several reasons as follows:

- The customer may be more likely to view the prototype and react to it rather than reading the SRS and react to it. Hence, the prototype provides faster feedback.
- The prototype reveals unanticipated aspects of the systems behavior. It produces not only answers but also new questions.
- An SRS based on a prototype tends to undergo less change during development. So a prototype shortens development time (IEEE, 1998d).

39. Objective: This question aims to find out if prototyping is a part of requirements definition phase. This question is considered with the system development methodology of the organization as prototyping is affiliated with methodologies such as Rapid Prototyping, Spiral Model, Extreme Programming and Agile Development.

39. Question: Is prototyping used to create more stable requirements during the requirements definition phase?

40. Standard: IEEE Standard 830 indicates that software requirements specification documents should have an emphasis on services and functions to be performed rather than specifying design items (IEEE, 1998d). Standard provides a list of issues that software requirements specification document should exclude related to software design such as:

- Partitioning the software into modules;
- Allocating functions to the modules;
- Describing the flow of information or control between modules;

- Choosing data structures.

40. Objective: This question firstly checks compliance to IEEE Standard 830 and aims to ensure that system requirements specification documents exclude design requirements and constraints.

40. Question: How does the company ensure that SRS documents exclude design requirements?

41. Standard: IEEE Standard 830 emphasizes that project requirements which represent an understanding between the customer and the supplier should not be included in the system requirements specification documents (IEEE, 1998d). Standard lists several documents that project requirements should better reside in such as software development plan, quality assurance plan.

41. Objective: This question firstly checks compliance to IEEE Standard 830 and later aims to ensure that system requirements specification document excludes project requirements.

41. Question: How does the company ensure that SRS documents exclude project requirements such as cost, delivery schedules?

42. Standard: This question refers to IEEE Standard 830. IEEE Standard 830 provides an outline that a good system requirements specification document should include in practice (IEEE, 1998d). Below table is an outline of a good system requirements specification document.

Table 5: Prototype Specification Document Outline

Table of Contents
1. Introduction
1.1 Purpose
1.2 Scope
1.3 Definitions, acronyms, abbreviations
1.4 References
1.5 Overview
2. Overall description
2.1 Product perspective
2.2 Product functions
2.3 User characteristics
2.4 Constraints
2.5 Assumptions and dependencies
3. Specific requirements
Appendices
Index

42. Objective: This question does not measure compliance to a specific standard. It has only been asked to compare the target company's SRS outline with an ideal SRS outline.

42. Question: How is the SRS document organized?

43. Standard: IEEE Standard 1074 indicates that after conducting the feasibility study system functions should be analyzed to identify total functions of the system. Standard also guides that after analyzing system functions, results should be mapped to functional description of the system (IEEE, 2006a).

43. Objective: This question firstly checks compliance to IEEE Standard 1074 and it verifies if system functions are analyzed following the feasibility study by the company. Moreover, question tries to find out how functional description of the system is drawn during system development process.

43. Question: Are system functions analyzed after the feasibility study? Is functional description of the system drawn from the system functions?

44. Standard: IEEE Standard 1074 defines a specific process named Develop System Architecture, which suggests that after definition of functional description of the system, system architecture should be extracted from the system functions included in functional description of the system (IEEE, 2006a).

44. Objective: Firstly, this question checks compliance to IEEE Standard 1074. Later, once the functional description of the system is completed, this question aims to verify whether company creates system architecture with respect to analyzed system functions.

44. Question: Is functional description of the system transformed into the system architecture using the methodology, standards, and tools that are established by the organization?

45. Standard: As a consequence of drawing system architecture from system functions, IEEE Standard 1074 suggests a decomposition of system requirements using system architecture to form software, hardware, interface requirements (IEEE, 2006a).

45. Objective: This question firstly checks compliance to IEEE Standard 1074 and it further verifies whether company decomposes system functions according to system architecture or not in order to form better system requirements.

45. Question: Are the system functions that are documented in the Functional Description of the System divided according to the System

Architecture in order to form software requirements, human and hardware requirements (if applicable), and the System Interface Requirements?

According to what system requirements are grouped by the company?

46. Standard: IEEE Standard 1074 takes interface requirements into consideration under its Define and Develop Software Requirements section. Standard suggests that all users, hardware, software interface requirements should be defined within the requirements documents because standard takes user interface as a critical issue in usability of the system (IEEE, 2006a).

46. Objective: This question firstly seeks out compliance to IEEE Standard 1074. Moreover, it verifies if system interface requirements are taken into consideration during requirement definition and analysis phase.

46. Question: Does the software requirements specifications work resulting in SRS document contain user interface requirements?

47. Standard: IEEE Standard 1074 guides that after definition and development of system requirements including interface requirements, requirement set should be reviewed by all related parties (IEEE, 2006a). The term related parties here refers to business units who are the actual users of the system.

47. Objective: This question firstly checks compliance of organization to IEEE Standard 1074 and aims to verify that the company has a mechanism to agree upon analyzed requirements. Approval of analyzed requirements is a consensus of opinion that analysis document covers all requirements stated by the business end.

47. Question: Is software requirements specification document subject to approval of business units to agree on defined system requirements?

48. Standard: IEEE Standard 1061 provides a framework for software quality metrics. Moreover, software quality metrics methodology provided with the framework allows organizations to establish quality requirements for a system at project outset which is given as a key factor to achieve software quality (IEEE, 1998e).

48. Objective: This question firstly checks compliance to IEEE Standard 1061 and it is asked to verify if company defines system quality requirements at the project outset using a defined methodology. This predecessor is a key factor of achieving software quality using software project quality assurance plan.

48. Question: Are quality requirements of a system established at the project outset?

49. Standard: IEEE Standard 730 provides a detailed section outline for software quality assurance plans and suggests this outline as a practice (IEEE, 2002). Standard also mentions that content of a software quality assurance plan is not limited with the outline given by the standard.

49. Objective: This question firstly checks compliance to IEEE Standard 730. Later, it provides the headlines of outline provided by the standard and performs a comparison between the standard and organization's practice.

49. Question: Is software quality assurance plan produced after the definition of system requirements?

50. Standard: IEEE Standard 1016 indicates the importance of software design description documents and document contents. In the audience section of the standard indicates that there are general users and creators of software design description documents (IEEE, 1998f). Standard mentions about technical staff as the creator the document.

50. Objective: First of all, this question checks compliance to IEEE Standard 1016. This question's objective is to verify if software design description documents are prepared by technical staff as mentioned in the standard. Standard indicates that designer in a technical role generally prepares design documents.

50. Question: Who prepares the software design description documents?

51. Standard: Though IEEE Standard 1016 does not indicate that an approval for software design descriptions should exist, it is a known fact that each step of a typical waterfall model is concluded with an approval which indicates satisfactory completion of the phase. Thus, an approval resulting from a peer-review by more experienced designers should exist at this stage.

51. Objective: This question checks if design results, namely design description documents, are approved by experienced designers to verify satisfactory content, and compliance to corporate standards.

51. Question: Who approves the design description documents?

52. Standard: IEEE Standard 1016 provides a design description organization and several design views that can be used to create a design description document (IEEE, 1998f). Below table is a summary of several

design aspects that should be included in a design description document given by the standard.

Table 6: Recommended Design Views

Design view representations	Scope	Entity attributes	Example representations
Decomposition description	Partition of the system into design entities	Identification, type, purpose, function, subordinates	Hierarchical decomposition diagram, natural language
Dependency description	Description of the relationships among entities and system resources	Identification, type, purpose, dependencies, resources	Structure charts, data flow diagrams, transaction diagrams
Interface description	List of everything a designer, programmer, or tester needs to know to use the design entities that make up the system	Identification, function, interfaces	Interface files, parameter tables
Detail description	Description of the internal design details of an entity	Identification, processing, data	Flowcharts, N-S charts, PDL

52. Objective: This question firstly checks compliance to IEEE Standard 1016 and later compares the structure of the design description document and design views prepared by the company with the standard.

52. Question: How is software design documents organized?

53. Standard: This question refers to three IEEE standards which are IEEE Standard 1074, IEEE/EIA 12207.0 and IEEE/EIA 12207.2. All of these standards mention about performing architectural design as the very first activity of design phase activities.

IEEE Standard 1074 defines performing architectural design as transforming software requirements and system architecture to high-level

design concepts (IEEE, 2006a). In fact, it is identification of software components that constitute the system. All internal interfaces among system components are defined within the software architectural design.

IEEE/EIA Standard 12207.0 provides a sequence of steps to create software architectural design as follows (IEEE& EIA, 1996):

- The developer should transform the requirements for the software item into an architecture that describes its top-level structure and identifies the software components. It is ensured that all the requirements for the software item are allocated to software components and further refined to facilitate detailed design.
- The developer should develop and document a top-level design for the interfaces external to the software item and between the software components of the software item.
- The developer should develop and document a top-level design for the database.
- The developer should develop and document preliminary versions of user documentation.
- The developer should define and document preliminary test requirements and the schedule for Software Integration.

53. Objective: This question firstly seeks out compliance to IEEE Standard 1074 and IEEE/EIA Standard 12207.0. Moreover, it checks if high level software architectural designs that presents each component of the software are created by the company.

53. Question: Is architectural design (hardware, software and network) performed to transform the software requirements and the system architecture into high-level design concepts? Who performs the architectural design?

54. Standard: IEEE Standard 1074 and IEEE/EIA Standard 12207.0 both suggest that following the high level design for the system, a detailed design should be prepared for each software component.

IEEE Standard 1074 defines detailed design as choosing design alternatives to implement the functions that are specified for each software component. Standard also annotates that by the end of this activity data structure, algorithm, and control information of each software component are specified (IEEE, 2006a).

IEEE/EIA Standard 12207.0 provides several steps that result in the production of software detailed design as follows (IEEE& EIA, 1996):

- The developer should develop a detailed design for each software component of the software item. The software components shall be refined into lower levels for coding, compilation and testing.
- The developer should develop a detailed design for external interfaces of the software, between the software components, and between the software units. The developer should also develop a detailed design for the database.
- The developer should define and document test requirements and schedule for testing software units.
- The developer should schedule software integration.

- The developer should evaluate the software detailed design and test requirements.

54. Objective: This question firstly checks compliance to IEEE Standard 1074 and IEEE/EIA Standard 12207.0. Later, it verifies if detailed designs are prepared following the software architectural design by the companies.

54. Question: Are detailed designs prepared indicating data structure, algorithm, and control information of each software component?

55. Standard: This question refers to. Though IEEE Standard 1074 and IEEE/EIA Standard 12207.0 don't indicate that there should be an approval for software design descriptions, it is a known fact that each step of a typical waterfall model is concluded with an approval which indicates satisfactory completion of the phase. Thus, an approval resulting from a peer-review by more experienced designers should exist for detailed design and architectural design activities.

55. Objective: This question aims to check if architectural design and detailed design are approved by experienced designers in order to verify accuracy and completeness of the documents.

55. Question: Are detailed designs and architectural designs approved by related parties? Who is authorized to approve software design descriptions?

56. Standard: IEEE/EIA Standard 12207.0 indicates that detailed design should also trigger the user documentation process by implementing preliminary versions and update user documentation as necessary (IEEE& EIA, 1996).

56. Objective: This question firstly checks compliance to IEEE/EIA Standard 12207.0 and aims to learn the prelude of user documentation. In addition to that, it checks whether preliminary user documentation is prepared by the software design personnel or not.

56. Question: Is preliminary versions of user documentation prepared by the design staff?

57. Standard: IEEE/EIA Standard 12207.0 indicates that preliminary versions of test requirements should be prepared during design phase by design staff (IEEE& EIA, 1996).

57. Objective: This question firstly checks compliance to IEEE/EIA Standard 12207.0 and it aims to learn where preliminary versions of test requirements are created in system development life cycle.

57. Question: Is preliminary versions of test requirements prepared by the design staff?

58. Standard: IEEE/EIA 12207.0 standard's development process indicates that developer should develop plans for conducting the activities of the development process. Furthermore, standard guides that these plans should be documented and executed (IEEE& EIA, 1996).

58. Objective: This question checks if development effort performed by development staff is correlated with a detailed development plan that contains activities, tasks of development process.

58. Question: Are development plans created for the development phase of the projects by development department personnel?

59. Standard: IEEE Standard 1074 indicates that source code should be generated including suitable comments in its Create Executable Code section (IEEE, 2006a).

59. Objective: This question firstly checks compliance to IEEE Standard 1074 and aims to verify if coding performed by the development personnel has to be compliant with the corporate commenting and coding standards. This fact provides continuity for organizations to keep up development effort even if development personnel leave the company.

59. Question: Are there any coding/commenting standards or procedures that development team has to apply during development? What are the standards in place?

60. Standard: IEEE Standard 1074 emphasizes that prior to the distribution of the software code reviews should be conducted (IEEE, 2006a). Reviews mentioned here are peer reviews to be performed by experience development professionals of software quality assurance specialists to verify compliance to corporate standards.

60. Objective: This question firstly checks compliance to IEEE Standard 1074 and verifies if the company performs a code review process in order to maintain quality for the source code and to verify compliance to corporate standards.

60. Question: Is there a review process for the coding to verify compliance to the corporate standards? What are the methods being used for the review process?

61. Standard: IEEE Standard 1074 has a dedicated process for operation documentation named Create Operation Documentation. This

process guides that following the creation of source code operation documentation should be created by related personnel. Standard also states that operation documentation is required to install, operate, and support the system throughout the life cycle (IEEE, 2006a).

61. Objective: First of all, this question checks company's compliance to IEEE Standard 1074 and it verifies if the company performs operational documentation to support installation, operation of the system throughout the life cycle.

61. Question: Are operating documents prepared for the developed system for installing, operating, and supporting the system throughout the life cycle?

62. Standard: IEEE Standard 1074 has defined post-development activities including Distribute Software process. This process puts emphasis on packaged software concept and states that software installation consists of transporting and installing the software from the development environment to the target environments. Moreover, standard indicates that software should be packaged while before distributing to target environments (IEEE, 2006a).

62. Objective: This question firstly checks compliance to IEEE Standard 1074 and it learns how software is packaged by the company while distribution. Software packages are a vulnerable issue in system development. It must be ensured that software package remains same while transferring to the test, integration and production environments so as to verify that only tested and approved and later securely packaged software is

transferred to the production environment. This issue prevents and minimizes problems in the live environment.

62. Question: How is the software to be delivered to test& integration environments packaged? Is it able to modify software after packaging?

63. Standard: IEEE Standard 828 provides minimum requirements of a software configuration management plan (IEEE, 2005). Standard gives a definition of SCM document stating that this document is intended to specify:

- What SCM activities are to be done?
- How they are to be done?
- Who is responsible for doing specific activities?
- When they are to happen?
- What resources are required?

63. Objective: This question firstly checks compliance to IEEE Standard 828. Moreover, it is asked to learn what portion of minimum objectives related to software configuration management plan is realized by the company.

63. Question: Does the company produce a software configuration management (SCM) plan for the whole system development process?

64. Standard: IEEE Standard 828 emphasizes that all of the external constraints on the SCM plan should be identified when these constraints relate to a procedure or a policy related to software configuration management (IEEE, 2005).

64. Objective: This question firstly seeks out compliance to IEEE Standard 828 and it is asked to check if software configuration management efforts in the company are governed by formal procedures and policies.

64. Question: Has the company documented a software configuration management procedure? What type of configuration management policy does the company use in practice?

65. Standard: IEEE Standard 828 states that tasks of software configuration management should be allocated to related units and this allocation and responsibilities should be documented in the process (IEEE, 2005).

65. Objective: This question firstly checks compliance to IEEE Standard 828 and aims to verify if the company prepares a responsibility and role assignment and documentation for software configuration management. This issue is a key factor for the success of software configuration management plans.

65. Question: Are roles and responsibilities documented for the SCM process?

66. Standard: IEEE Standard 1074 has a dedicated process for release management which is entitled as Plan Release Management. Besides, standard guides on what release management planning should include such as release management organizations and responsibilities, procedures, tools, techniques, and methodologies, release frequency, release milestones, release media, build procedures and naming conventions, branching models, packaging requirements, and delivery media (IEEE, 2006a).

66. Objective: First of all, this question seeks out compliance to IEEE Standard 1074. Moreover, it aims to learn release management planning approach of the company during a systems development life cycle. Furthermore, an ingredient of the release management plan that is used by the company is checked with the question.

66. Question: Does the company create a release management plan that contains overall software release management objectives, including release frequency, release milestones, and release media?

67. Standard: Although IEEE Standard 828 does not indicate necessity of a configuration management system, terms mentioned in the standard such as version naming standards, naming configuration items, acquiring configuration items, configuration items access are generally governed by configuration management systems.

67. Objective: This question aims to check if the company uses a configuration management system for maintaining, versioning configuration items. Besides, this question is an informational question that will not return any issues and problems. Because, related standard merely indicates system related issues but does not enforce or suggest existence of a configuration management system.

67. Question: Is there a versioning system used for the configuration items? Are the configuration items governed by a system?

68. Standard: This question refers to IEEE Standard 828. This standard has a specific section for naming configuration items. Standard indicates that software configuration management plan should also include

standard methods for naming and labeling configuration items (IEEE, 2005).

68. Objective: This question firstly checks compliance to IEEE Standard 828 and verifies if the company applies standards for naming and labeling of configuration items such as release and release documentation.

68. Question: Are there any standards in place related to version naming, marking, documentation labeling for the releases?

69. Standard: This question refers to IEEE Standard 828. This standard has a section dedicated to acquiring configuration items. Standard suggests that access control procedures should be referenced in the software configuration management plan for each configuration item and configuration library (IEEE, 2005).

69. Objective: This question aims to check existence of standards set by the organization related to access to software libraries. In a reliable and organized environment, access control to software items is a vulnerable issue and should be managed with attention.

69. Question: Are there any procedures related to access to the software libraries and retrieval of configuration items from software libraries? What are the access rights for several user groups? Is everyone able to access and retrieve configuration items?

70. Standard: IEEE Standard 828 provides guidance for configuration control which includes requesting changes, evaluating changes, approving disapproving changes and implementing changes. Standard suggests that software configuration management plan should address change controls imposed on the baseline configuration items such as

identification of change, analysis and evaluation of a change request, approval or disapproval of a change request, verification, implementation, and release of a change (IEEE, 2005).

70. Objective: First of all, this question seeks out compliance to IEEE Standard 828 and it aims to learn the change process on baseline configuration items. Thus, question checks if changes on baseline configuration items are managed via a predefined plan or process.

70. Question: How is the change process on baseline configuration items managed? How is change identified and documented? How the change request is recorded, analyzed and evaluated? How is the change request approved or disapproved? How is the change implemented and released?

71. Standard: IEEE Standard 828 emphasizes that both change requests and records to track sequence of change process should be kept and identified by the software configuration management plan (IEEE, 2005).

71. Objective: This question firstly seeks out compliance to IEEE Standard 828 and checks change control mechanisms of the target company for baseline configuration items. Question checks if change requests are recorded and tracked manually and if configuration management system itself creates change log for baseline configuration items.

71. Question: Is there a change log kept by the SCM system regarding the details of changes on configuration items? For how long are the logs kept? Are the logs removed completely after some time?

72. Standard: IEEE Standard 828 guides that if there is a vendor or subcontractor within the system development project, there should be a

monitoring process within the software configuration management plan to ensure compliance to the organization's system development standards (IEEE, 2005).

72. Objective: First of all, this question verifies compliance to IEEE Standard 828 and it checks if there is a monitoring process for subcontractors to ensure compatibility with the company's system development standards. This process should be taken into consideration due to organizational, legal relationships and quality of the output.

72. Question: If the coding stage of the system development process is outsourced what kind of monitoring process is in place for the contractors?

73. Standard: IEEE Standard 828 indicates that some issues of subcontracting should be planned beforehand in the software configuration management plan, including reviews to be performed on subcontractor's configuration items (IEEE, 2005).

73. Objective: This question firstly seeks out compliance to IEEE Standard 828 and intends to verify if the company performs a review process on subcontracted software. This issue is critical to gain the maximum value from the outsourced software in terms of corporate software quality standards.

73. Question: How the work of the contractor is reviewed for compliance with the development standards of the enterprise?

74. Standard: IEEE Standard 828 suggests that planning of testing, verification, and acceptance should be performed beforehand for subcontracted software. In fact, standard guides that planning information of

these activities should be embedded to Software Configuration Management Plan (IEEE, 2005).

74. Objective: First aim of the question is to verify compliance to IEEE Standard 828. Moreover, this question intends to learn the process that is applied to subcontracted software in terms of testing, verification, acceptance, integration. This issue is critical because total quality of the system is a sum of subcontracted software's quality, process applied to measure the quality and compliance of the subcontracted software to corporate standards.

74. Question: How external code, documentation, and data of the contractor is tested, verified, accepted, and merged with the project software? Is there a review process for the outsourced coding?

75. Standard: IEEE Standard 1062 has divided software acquisition process into nine steps second of which is Implementing Organization's Process. First step of this process guides to establish a software acquisition process that fits the organization's needs (IEEE, 1998b).

75. Objective: First objective of this question is to verify compliance to IEEE Standard 1062. This question inquires the very first requirement related to software acquisition. Question checks if the company has created and documented a software acquisition process to be implemented throughout the software acquisition cycle.

75. Question: Does the company have a defined software acquisition process for outsourcing the software?

76. Standard: IEEE Standard 1062 has established five milestones for software acquisition first of which is called Planning Phase. Planning

phase includes release of Request for Proposal (RFP) document and this phase is stated to begin when RFP is created by the organization (IEEE, 1998b).

76. Objective: First objective of this question is to verify compliance to IEEE Standard 1062. This question is asked to check if company produces RFP documents for software acquisition. RFP is a document used by the acquirer as a means to announce intention to potential bidders to acquire a specified system or software product.

76. Question: Does the company produce Request for Proposal (RFP) document which contains requirements for the software to be purchased and product quality and maintenance plans? Who is responsible of preparing the RFP document?

77. Standard: IEEE Standard 1062 divides software acquisition process into nine phases third of which is Defining Software Requirements. In order to evaluate proposals resulting from the RFP documents, this standard suggests that companies should have set supplier evaluation criteria. This standard also provides methods to identify suppliers (IEEE, 1998b).

77. Objective: This question firstly verifies compliance to IEEE Standard 1062 and it aims to check existence of company's supplier selection and evaluation criteria. Because, a defined selection and evaluation criteria should exist in order to provide a fair evaluation process and find the most suitable supplier.

77. Question: How are the potential suppliers identified and evaluated? Please explain company's supplier evaluation and selection criteria?

78. Standard: IEEE Standard 1062 divides software acquisition process into nine phases third of which is Defining Software Requirements. In this section of the standard there is a sub process to establish supplier proposal evaluation standards. This process suggests that company should have developed a set of supplier evaluation criteria to use in reviewing supplier proposals (IEEE, 1998b).

78. Objective: First objective of this question is to check compliance to IEEE Standard 1062. This question aims to verify if there are standards used for supplier evaluation. These standards should be fairly applied to all proposals by using predefined evaluation criteria so as to select the most suitable supplier.

78. Question: How is supplier proposals evaluated?

79. Standard: IEEE Standard 1062 divides software acquisition process into nine phases fifth of which is Preparing Contract Requirements. This step suggests that quality of work to be done should be clearly stated in the contract in terms of acceptance criteria. These criteria are later used in detail when accepting the software (IEEE, 1998b).

79. Objective: First objective of this question is to verify compliance to IEEE Standard 1062. Moreover, it aims to check the terms and conditions set by the organization to accept the software during contracting phase. If acceptance criteria is not clearly defined in the contract this may result in discrepancies and inefficiency of the system in meeting company's

expectations. Company should force suppliers to satisfy all the criteria defined in the contract by acceptance testing and make sure that all errors and problems are corrected by the supplier.

79. Question: Are acceptance criteria defined at the contracts for selected suppliers?

80. Standard: IEEE Standard 1062 divides software acquisition process into nine phases fifth of which is Preparing Contract Requirements. In the first step of this process standard suggests to define statement of work indicating responsibilities of supplier and the company for each task during the project (IEEE, 1998b).

80. Objective: This question firstly verifies compliance to IEEE Standard 1062 and later aims to check the statement of obligations of the supplier and the acquirer in the contracts. Moreover, question checks if there is a dissemination of defined contract tasks to the supplier and the acquirer. This issue is critical for the acquirer side to be able to force the supplier legally in terms of agreed requirements in the contract.

80. Question: Are supplier and acquirer obligations stated and agreed at the contract?

81. Standard: This question refers to the standard 1996. According to IEEE/EIA Standard 12207.0, the third primary software life cycle process is development. Under the Software Coding and Testing subsection of the development process, standard suggests that each software unit and database developed by the developer should be documented (IEEE& EIA, 1996).

81. Objective: First objective of this question is to verify compliance to IEEE/EIA Standard 12207.0. Moreover, this question checks if

development effort performed by developers is followed by a documentation that describes in detail what has been implemented using which methods. This issue is critical in traceability of the coding by peers and allowing information sharing between development staff. Moreover, it is a preventive control that eliminates information and knowledge losing when developers of specific modules leave the company.

81. Question: Is each software unit or database developed documented by the related development staff? Who is in charge of coding documentation?

82. Standard: IEEE/EIA Standard 12207.0 suggests that following the coding phase of the software, test data and test procedure for testing each software unit should be developed and documented by the developers (IEEE& EIA, 1996).

82. Objective: First objective of this question is to verify compliance to IEEE/EIA Standard 12207.0. In addition to that, it checks if test procedures and test data for unit testing is created and documented by the developers in the organization. If such a process is followed company is able to track how unit testing has been performed and using which type of data.

82. Question: Are test procedures and test data created? Who develops test plans and test data?

83. Standard: According to IEEE/EIA Standard 12207.0, the third primary software life cycle process is development. Under the Software Coding and Testing subsection of the development process standard

suggests that developer should test each software component and document the results (IEEE& EIA, 1996).

83. Objective: First objective of this question is to verify compliance to IEEE/EIA Standard 12207.0. Moreover, it checks if unit testing is performed following the development effort. Unit testing is a major process of system development that enables early detection and correction of problems resulting from the fresh development. In addition to that, unit testing allows organizations to focus on product feature and system testing instead of dealing with the bugs that blocks testing process.

83. Question: Is developed software subject to unit testing? Who performs the unit testing? Are the test results documented?

84. Standard: IEEE/EIA Standard 12207.0 and IEEE/EIA Standard 12207.2 both denote that the developer should develop an integration plan to integrate the software units and document the plan (IEEE& EIA, 1996).

84. Objective: This question firstly verifies compliance to IEEE/EIA Standard 12207.0 and IEEE/EIA Standard 12207.2. Moreover, it checks if company performs planning for integration testing. Integration testing is a critical issue in the verification of compatibility between different software units and components.

84. Question: Is integration testing plan created/documented? Who plans and documents integration tests?

85. Standard: IEEE/EIA Standard 12207.0 denotes that early versions of user documentation should be prepared following the software architectural design. Moreover, standard states that software user

documentation should be updated as necessary in the development process (IEEE& EIA, 1996).

85. Objective: This question firstly seeks out compliance to IEEE/EIA Standard 12207.0. Moreover, it aims to check where user documentation starts in the system development life cycle. Although there is not a certain phase that user documentation should start, it should be available right after the implementation of the system in order to enable user adaptation to the system.

85. Question: Is draft user documentation started at the development phase? If no at which phase does the user documentation start?

86. Standard: IEEE Standard 1074 suggests that test procedures for different levels of tests should be prepared as an input to preparation of test data and execution of the tests including unit, module, component, integration, acceptance, regression, and system tests. Moreover, standard indicates that test procedures should define types of tests to be conducted such as white box, black box, destructive, noninvasive tests (IEEE, 2006a).

86. Objective: First objective of this question is to verify compliance to IEEE Standard 1074 and this question checks if test procedures for different levels and types of testing have been established by the organization. Procedures related to the tests are critical as they define the methods and test approach and they standardize the way of test performance within the organization.

86. Question: Has the company established test procedures for the following?

87. Standard: IEEE Standard 1074 divides software life cycle processes into six phases first of which is Project Management. Second sub process of Project Management is Project Planning which includes integration planning. This sub process suggests that combining software components into a system should be planned beforehand (IEEE, 2006a).

87. Objective: First objective of this question is to verify compliance to IEEE Standard 1074. Moreover, it checks if the company performs software integration planning in the project planning phase. As software integration is a major phase of system development life cycle it should be planned in detail at the project planning phase.

87. Question: Are integration plans created for system development projects to combine software components into an overall system?

88. Standard: IEEE/EIA Standard 12207.0 and IEEE/EIA Standard 12207.2 divide primary software life cycle into five phases third of which is the development process. In the System Integration sub process of development process it is stated that after integrating software components with hardware items and other systems, aggregates should be tested and integration test results should be documented (IEEE& EIA, 1996).

88. Objective: First of all, this question verifies compliance to IEEE/EIA Standard 12207.0 and IEEE/EIA Standard 12207.2. In addition to that, it aims to check if the company performs an integration testing by combining software components, hardware and the other systems. Integration testing is a crucial part of the system development process since it provides a result in the compatibility of the software with other system components and other systems. Moreover, question checks if the company

retains results of integration tests to refer in case of a problem in the process.

88. Question: Is integration testing performed? Are the results of integration testing documented?

89. Standard: IEEE Standard 1074 defines post-development activities first of which is Installation Activities. In addition to that, a detailed explanation of installation is given within the standard stating that installation consists of the transportation and installation of software from the development environment to the target environment (IEEE, 2006a).

89. Objective: This question is intended to be an informational question regarding the package transfer between environments. Although it is not mentioned in the standard, in order to ascertain that package remains same while transferring between the environments, this task should be performed by personnel different than the development personnel.

89. Question: Which organizational unit is responsible of checking out the software from the development environment and transferring to target environments?

90. Standard: IEEE Standard 1074 defines post-development activities first of which is Installation Activities. In addition to that, a detailed explanation of software installation is given within the standard stating that packaged software, and any required database data, should be installed in the target environment according to the procedures of the organization (IEEE, 2006a).

90. Objective: This question is intended to be an informational question regarding the installation of test environment. Although it is not

mentioned in the standard, in order to ascertain that package remains same while transferring between the environments and test environment is not accessible by development personnel, installation effort should be assigned to a special group rather than developers of the software. This precaution also enhances segregation of duties within the organization.

90. Question: Which organizational unit is responsible of installing the test environment?

91. Standard: IEEE Standard 1074's sub process named Develop Test Procedures suggests that test procedures should cover test environment components and data to be used in testing (IEEE, 2006a). In fact, existence of test environments is to simulate production environment and detect errors earlier in the process.

91. Objective: This question firstly checks compliance to IEEE Standard 1074. Later on, it aims to learn company's approach in simulating production environment as much as possible in the test environment. In order to detect errors and problems earlier in the process, test environment should be kept as much as similar to the production environment.

91. Question: How does the organization ensure that test environment reflects production environment as much as possible (data, tools)? Which method is used to keep test environment similar to production environment as much as possible?

92. Standard: Install Software activity of development section of activity groups in IEEE Standard 1074 suggests that installation to the target environments should be documented with the problems encountered during installation (IEEE, 2006a).

92. Objective: This question firstly verifies compliance to IEEE Standard 1074. Moreover, it aims to assess if companies document and retain problems encountered during installation. This activity is critical in the way that same problems will be encountered during deployment to production. Nevertheless, problems should be identified and documented earlier to be resolved by related parties before production.

92. Question: Is operation log of the installation kept to keep track of encountered problems during installation?

93. Standard: IEEE Standard 829 defines the purpose of the test plans to be used in the testing process with several dimensions and mentions several aspects that a test plan should include such as scope, approach, resources, and schedule of the testing activities. Moreover, standard also indicates that test plan should include issues like items being tested, the features to be tested, the testing tasks to be performed, and the personnel responsible for each task (IEEE, 1998g).

93. Objective: First of all, this question intends to verify compliance to IEEE Standard 829. Moreover, it checks in detail which dimensions of software testing are considered in the software acceptance test plans. Actually, it checks if the acceptance test plans prepared by the companies carry out purposes of a test plan.

93. Question: Are acceptance test plans produced with respect to the analysis documents? Who prepares the acceptance test plan document?

94. Standard: In the test plan section of IEEE Standard 829 it is suggested to place an approvals section where names and titles of the persons to approve the test plan are documented (IEEE, 1998g).

94. Objective: This question assesses if the test plans prepared within the company is approved by related parties. Approval of test plans are required in the process in order to verify that scope, approach, resources, features to be tested, testing tasks and schedule of the plan is feasible and they are consistent with the corporate standards and procedures.

94. Question: Who approves acceptance test plans?

95. Standard: According to IEEE Standard 829, test specification is covered by three document types one of which is test design specification and the others are test case and test procedure specification. Standard states that test design specification document is used to refine test approach and identify the features to be covered by the design and its associated tests. It also identifies the test cases and test procedures, required to execute testing and specifies the feature pass/fail criteria for test cases (IEEE, 1998g). Furthermore, this standard provides an outline for test design specification content including test design specification identifier, features to be tested, approach, test identification, pass/ fail criteria.

95. Objective: First objective of this question is to verify compliance to IEEE Standard 829. Furthermore, it checks if test design specification document is prepared by the organization. Moreover, it checks if required components of a test design specification are created by the organizations. Test design specification documents are critical along the process because they precisely define the test approach and methods to be used and pass/fail criteria for the software features.

95. Question: Are test design specification documents prepared?

Who prepares the documents?

96. Standard: According to IEEE Standard 829, one of the crucial elements of test specification is test case specification which should be in harmony with the test design specification. Standard provides purpose of test case specification as to define a test case identified by a test design specification. Furthermore, this standard gives a structure that a test case specification document should have including test case identifier, test items, input specifications, output specifications, environmental needs, special procedural requirements, and intercase dependencies (IEEE, 1998g).

96. Objective: This question firstly verifies compliance to IEEE Standard 829. Later on it checks if test case specification document is prepared by the organization. Moreover, it checks if required components of a test case specification are created by the organizations. Test case specification documents are required along the process because they identify input output parameters, items for each test case which is actually the heart of testing process. Output specifications of the test cases are expected values or results in accordance with software requirements.

96. Question: Are test case specification documents prepared? Are test specifications and constraints defined per test cases?

97. Standard: IEEE Standard 829 defines four report types that should be produced during test execution two of which are test log and test incident report. Test log is defined as record of what occurred during test execution and test incident report is defined as any event that occurs during the test execution which requires further investigation (IEEE, 1998g).

97. Objective: First of all, this question seeks out compliance to IEEE Standard 829. Moreover, it learns company's approach to test logging

and test incident reporting. It checks if the company keeps logs of tests performed and the actions taken for the incidents during testing. Test logging is required along the process to keep minutes of the test in case required in the future because of a problem. Besides, incident reporting provides timely feedback to related parties where bigger effects might show up in the future.

97. Question: Is test log prepared by the test team during test execution? What actions are taken for the incidents?

98. Standard: IEEE Standard 829 places an approval section for test summary report which indicates that test summary reports should be approved to ascertain test results are compliant with company's standards and tests are executed with respect to defined test cases and test designs (IEEE, 1998g).

98. Objective: This question firstly verifies compliance to IEEE Standard 829. After that, it checks if test summary reports prepared by the company are approved by related parties. Approval of test summary reports are required in the process in order to verify that tests are performed with respect to given test design descriptions and test case descriptions. An approval process also is a good mechanism to control if executed tests are compliant with corporate procedures and standards.

98. Question: Are test summary reports approved? Who approves?

99. Standard: IEEE Standard 1062 defines nine phases for software acquisition where number eight in the process is accepting the software. Standard defines that there should be an established process to certify

correction of discrepancies and satisfaction of acceptance criteria (IEEE, 1998b).

99. Objective: First objective of this question is to verify compliance to IEEE Standard 1062 and this question intends to check company's approach in accepting package software. Companies should have defined an acceptance process for package software which may be the same process applied to in-house software or a tailored and specific process for package software. Moreover, a predefined process for this purpose eases up a fair evaluation of supplier's software.

99. Question: What type of software acceptance process is applied to the suppliers (package software purchase)?

100. Standard: Development section of activity groups in IEEE Standard 1074 contains an activity named Accept Software in Operational Environment. This activity suggests that a user acceptance should be performed to verify that developed software satisfy defined customer requirements (IEEE, 2006a).

100. Objective: First of all, main objective of this question is to verify compliance to IEEE Standard 1074. Furthermore, it aims to learn the method applied by the company's customers to accept developed software. Customer acceptance is a critical step in the process since it allows an agreement between the customer and development groups indicating that system is developed with respect to customer requirements.

100. Question: How does the customer accepts the developed software? What is the practice of the company?

101. Standard: In the Accept Software in Operational Environment activity of IEEE Standard 1074 it is indicated that related project information should be collected and placed in the project records. One of the records to be kept in the project records is the result of user acceptance testing (IEEE, 2006a).

101. Objective: First of all, this question verifies compliance to IEEE Standard 1074. Furthermore, it checks the existence of approvals for the results of user acceptance testing. Results of user acceptance testing should be approved either by the business end representatives or project responsible such as project manager or project coordinator. This is a sign off process which is an indicator that shows satisfactory completion of user acceptance testing. In addition to that, software development completion project information mentioned in the standard covers documentation of user acceptance testing results for future reference in case of problems.

101. Question: Are the results of the UAT test approved? Who approves? Are the results of the UAT documented?

102. Standard: IEEE Standard 1074 (2006a) mentions software installation activities and this question is an extension of Question 89. There are two questions regarding the transfer of software packages. Because, software transfer from development to test environment and from test to production environment must be segregated by the companies. This question deals with the second part of the transfer process namely from test environment to the production environment. Further reference is not given as this question refers to the same part of the standard used in Question 89.

102. Objective: First objective of this question is to verify compliance to IEEE Standard 1074. This question intends to learn the unit responsible for software transfer from test environment to production environment and this part of the question is wholly informational. Furthermore, it checks the conditions to perform the transfer which must exist and may contain approval of related parties, percentage of success in user acceptance testing.

102. Question: Which organizational unit is responsible of transferring the software components from test system to production environment? Which conditions are asked to perform the transfer?

103. Standard: In the Operation and Support Activity Group of IEEE Standard 1074 a specific activity has been defined which is named Operate the System. This activity gives a brief activity description regarding operation of the system. According to this definition, installed software should be utilized in the intended environment in accordance with the operating instructions (IEEE, 2006a).

103. Objective: This question firstly checks compliance to IEEE Standard 1074 and it aims to learn company's approach to operate the system. Firstly, question retrieves an information regarding the unit responsible for system operation than it tries to assess according to what system is operated within the organization. In the best practice, company should have set standard operational procedures or instructions to guide and control the operation process.

103. Question: Which organizational unit operates the production environment? How?

104. Standard: In the Operate the System activity of IEEE Standard 1074 it is annotated that feedback data is collected for system tuning and product improvement (IEEE, 2006a). This is only applicable where a monitoring process is applied for systems which have recently been promoted to production environment.

104. Objective: First objective of this question is to verify compliance to IEEE Standard 1074. Moreover, this question intends to check the actions that company takes for a system that is recently deployed into the production environment. As soon as the system goes live, system should be monitored for some time in order to identify and prevent problems earlier in the implementation process.

104. Question: Is the system at the implementation stage monitored for some time in case of errors?

105. Standard: In the Process Implementation activity of Operation Process in IEEE/EIA Standard 12207.0, it is indicated that procedures for receiving, resolving, tracking problems should have been established by the organization (IEEE& EIA, 1996).

105. Objective: Initial objective of this question is to verify compliance to IEEE/EIA Standard 12207.0. In addition to that, this question checks if problems encountered during and after implementation are governed by formally documented procedures by the organization. Operations that are carried out with standard procedures allow standardization for the organizations.

105. Question: Has the company established procedures related to the problems encountered at the operation environment during and after implementation?

106. Standard: In the Process Implementation activity of Operation Process of IEEE/EIA Standard 12207.0, it is suggested that whenever problems are encountered they should be recorded and further investigated for resolution (IEEE& EIA, 1996).

106. Objective: First of all this question controls compliance to IEEE/EIA Standard 12207.0. Later it checks if the company keeps record of problems encountered during or after implementation. This issue is critical in the way that each problem encountered while implementation should be further investigated until its resolution by the company.

106. Question: Does the company keep track of the problems encountered at the operation environment during implementation?

107. Standard: This question refers to the standard IEEE/EIA 12207.0 1996. In the System Operation activity of Operation Process of IEEE/EIA Standard 12207.0, it is suggested that system should be operated with respect to the user documentation (IEEE& EIA, 1996).

107. Objective: First of all, this question aims to control compliance to IEEE/EIA Standard 12207.0. Moreover, it aims to check how the company ensures that system in the production phase is used as guided in the user documentation. Company should have set policies and a procedure related to operation of the system and receives continuous feedback from the users. Moreover, there should be stimulating processes to use operational guidelines.

107. Question: How does the company ensure that the implemented system is operated according to the user documentation?

108. Standard: Under the Operation process of IEEE/EIA Standard 12207.0, User Support activity suggests that company should provide assistance and consultation to system users when necessary (IEEE& EIA, 1996).

108. Objective: Initial objective of this question is to control compliance to IEEE/EIA Standard 12207.0. In addition to that, it intends to check company's approach to help desk concept. In order to use the system in most efficient way company should have established a unit which helps users whenever necessary.

108. Question: Does the company provide assistance to system users when necessary? Which organizational unit is responsible for the assistance?

109. Standard: IEEE Standard 1062 defines software acquisition process in nine steps ninth of which is Use Software. In this process standard suggests that supplier performance should be evaluated after the acceptance of software and performance data should be retained for future reference (IEEE, 1998b).

109. Objective: After, controlling compliance to IEEE Standard 1062, this question checks if the company performs an evaluation of the supplier for acquired off-the-shelf products. Long term advantage of supplier evaluation is a decision input for future acquisitions and supplier decisions.

109. Question: How is the supplier performance evaluated for acquired software?

110. Standard: IEEE Standard 1063 provides minimum requirements for the structure, information content and format of user documentation (IEEE, 2001b).

110. Objective: This question checks if the company has defined a governing documentation procedure in order to guide authors for the structure, minimum information content and several aspects of documentation. Although, process based constraints are not mentioned in the standard, it is essential to build user documentation procedures to enforce timely documentation and users' early adaptation to new systems.

110. Question: Does the company have policies/procedures related to software user documentation?

111. Standard: In order to ensure timely delivery of documentation IEEE Standard 1074 suggests that a documentation plan should be developed in the project planning activities (IEEE, 2006a). Standard also guides that documentation plan should include responsibilities, information sources, resource allocations, and intended audiences.

111. Objective: After verifying compliance to IEEE Standard 1074, this question checks if the company has a structured and planned approach to user documentation.

111. Question: How does the company ensure that user documentation is completed in a timely manner?

112. Standard: IEEE/EIA Standard 12207.0 defines documentation process as a support process of software life cycle primary processes. In the

process implementation step of documentation process standard defines procedures for several aspects of documentation such as inputs, development, review, modification, approval, production, storage, distribution, maintenance (IEEE& EIA, 1996).

112. Objective: This question firstly checks compliance to IEEE/EIA Standard 12207.0. Moreover, it aims to check existence of company's procedures related to documentation in detail. Each required document in the system development life cycle should be defined and company should have set procedures related to several aspects of the documentation such as inputs, development, review, modification, approval.

112. Question: Does the company have a documentation procedure to be used throughout the system development life cycle?

113. Standard: IEEE Standard 1074 defines maintenance activities under the Post-Development Activity Groups. Standard does not address a specific unit or workgroup for the maintenance but defines activities for the maintenance process which is required throughout system life cycle (IEEE, 2006a).

113. Objective: This question intends to retrieve information regarding several dimensions of maintenance carried out by the companies such as hardware, software and network and inquires if company has a responsible unit for system maintenance.

113. Question: Which organizational unit is responsible of the system maintenance?

114. Standard: IEEE/EIA Standard 12207.0 defines maintenance process in detail including definition of the process and steps to implement

the process. In the process implementation step of the process, standard suggests that companies should establish procedures for several aspects of problem reporting and modification requests (IEEE& EIA, 1996).

114. Objective: First of all, this question verifies compliance to IEEE/EIA Standard 12207.0. Furthermore, it checks existence of procedures related to problem reporting and modification requests within the company. Existence of such procedures allow standardization of maintenance process for the inside customers and maintainers.

114. Question: Has the company established procedures for receiving, recording, and tracking problem reports and modification requests from the users and providing feedback to the users?

115. Standard: ISO/IEC Standard 14764 and IEEE Standard 14764 divide maintenance process into six phases first of which is process implementation. This sub process suggests that a maintenance plan should be developed to use during maintenance process (ISO& IEC& IEEE, 2006b). However, standard guides that maintenance plan should document company's strategy to maintain the system.

115. Objective: After verifying compliance to ISO/IEC Standard 14764 and IEEE Standard 14764, this question checks existence of maintenance plans for system development process. Maintenance plans are critical in the process because they set maintenance strategy and schedule.

115. Question: Does the company prepare maintenance plans for the system development projects?

116. Standard: IEEE Standard 1219 has divided software maintenance into seven phases first of which is Problem/modification

identification, classification, and prioritization. In this step, it is given that input of a problem is a maintenance request and it should be stored in a repository by a unique identifier (IEEE, 1998h).

116. Objective: This question is an informational question which gathers information regarding the first trigger of the maintenance process and it does not carry a specific objective.

116. Question: How is maintenance requests generated in the maintenance process?

117. Standard: IEEE Standard 1219 has divided software maintenance into seven phases first of which is Problem/modification identification, classification, and prioritization. In this step's process definition, it is given that every maintenance request should be classified and prioritized along the process (IEEE, 1998h).

117. Objective: Having verified compliance to IEEE Standard 1219, this question checks if the company classifies and prioritizes maintenance requests. This issue is critical along the process since it allows easier follow-up of maintenance and put more emphasis on higher priority requests.

117. Question: How is the maintenance requests generated, classified and prioritized?

118. Standard: ISO/IEC Standard 14764 and IEEE Standard 14764 divide maintenance process into six phases second of which is problem and modification analysis. This sub process suggests organizations to document maintenance requests and results.

118. Objective: After verifying compliance to ISO/IEC Standard 14764 and IEEE Standard 14764, this question checks if the company

retains records of maintenance requests. This issue is important in the way that provides performance measures for maintenance handling in the organizations. Moreover, a systematic recording approach for maintenance request enables organizations to follow a defined process and analyze the maintenance request in detail.

118. Question: How does the company record/document maintenance requests?

119. Standard: IEEE Standard 1219 has divided software maintenance into seven phases second of which is analysis phase. In this step's process definition, standard suggests to perform feasibility study in several dimensions such as impact of modification, alternate solutions, analysis of modification requirements, safety and security issues, human factors, short and long-term costs, and value of performing the modification (IEEE, 1998h).

119. Objective: Having verified compliance to IEEE Standard 1219, this question checks if the company performs a feasibility study after receiving maintenance requests. This issue is critical because it provides beneficial information for the organization that helps to assess results and impacts of the maintenance.

119. Question: Is feasibility for maintenance requests prepared?

120. Standard: IEEE Standard 1219 has divided software maintenance into seven phases second of which is analysis phase. In this step's process definition, standard suggests to perform a detailed analysis in several dimensions including identification of modification elements (IEEE, 1998h).

120. Objective: First of all, this question verifies compliance to IEEE Standard 1219. This question also checks if the company performs a detailed analysis after receiving maintenance requests. This issue is critical because it provides foresight for the organization to deeper define firm's requirement in terms of resources and allows breakdown of modification to system components like hardware, software or network.

120. Question: Is a detailed analysis performed to define requirements of the firm to identify elements of the modification (documentation, code, and database) and portions of the modification on these elements?

121. Standard: IEEE Standard 1219 has divided software maintenance into seven phases second of which is analysis phase. In this step's process definition, standard suggests to perform a detailed analysis in several dimensions and to develop an initial implementation plan (IEEE, 1998h). Standard also guides that initial implementation plan should state how the design, implementation, testing, and delivery of the modification will be performed by the organization to ensure minimal impact to current users.

121. Objective: After verifying compliance to IEEE Standard 1219, this question checks if the company creates a preliminary implementation plan after receiving maintenance requests. A preliminary plan is critical along the maintenance process because it has a user orientation which aims to create minimal impact on current users by the nature of change.

121. Question: Is a preliminary implementation plan created to ensure a minimal impact to current users?

122. Standard: IEEE/EIA Standard 12207.0 defines a sub process named maintenance review/acceptance under maintenance process, which suggests getting an approval from the users for completeness of maintenance (IEEE& EIA, 1996).

122. Objective: Having verified compliance to IEEE/EIA Standard 12207.0, this question analyzes if the company receives a feedback from the customer regarding the satisfactory completion of maintenance. This issue should take place between testing of maintenance and migration to production to agree with the business units on the modification time.

122. Question: Does the maintenance unit ask for approval from the business unit for implementation of the selected modification?

123. Standard: IEEE Standard 1219 has divided software maintenance into seven phases second of which is analysis phase. In this step's process definition, standard suggests to perform a detailed analysis in several dimensions and to devise a test strategy. Standard underlines at least three types of tests, namely individual element tests, integration tests, and user-oriented functional acceptance tests, requirements of which should be defined in the test strategy (IEEE, 1998h).

123. Objective: Further than verifying compliance to IEEE Standard 1219, this question intends to check if the company creates a set of requirements in the analysis phase for different levels of tests that is going to be executed due to maintenance of the system. Test requirements mentioned hereby are considered for planning of maintenance and defined to review test resources and capabilities beforehand.

123. Question: Are requirements for testing modification elements defined as a test strategy?

124. Standard: IEEE Standard 1219 suggests that after implementation of the maintenance, as outputs of this phase test documentation (test plan, test cases, test procedures), training and technical documentation, design documentation and user documentation should be updated accordingly (IEEE, 1998h).

124. Objective: First of all, this question verifies compliance to IEEE Standard 1219. Moreover, it checks the actions taken on documentation resulting from maintenance. All related project documentation that is affected by the maintenance should be updated including but not limited to test documentation (test plan, test cases, and test procedures), training and technical documentation, design documentation and user documentation.

124. Question: What actions are taken for documentation change requirements resulting from maintenance? Is the update verified?

125. Standard: IEEE Standard 1219 has divided software maintenance into seven phases fourth of which is implementation phase. In this step which comes right after the design phase step, it is suggested that one of outputs of this phase should be updated user documentation (IEEE, 1998h).

125. Objective: After verification of compliance to IEEE Standard 1219, this question intends to check the actions taken for user documentation where system design baselines have changed in the maintenance process. If there is a significant change in the design such as

screen design, software design; user documentation should also change accordingly in order to create the minimal impact on current system users.

125. Question: Is software (system/user) documentation updated due to the changes in design resulting from the maintenance?

126. Standard: IEEE Standard 1219 has divided software maintenance into seven phases third of which is design phase. In this phase's process definition it is suggested that software module documentation should be updated and it should be verified that new/updated software design document is created as a result of maintenance (IEEE, 1998h).

126. Objective: This question intends to analyze the actions taken for software design documentation if there is a significant change in the design resulting from software maintenance. Update of design documents is critical in the process in order to prevent the gap between maintained software and its documentation. If design document is not updated during maintenance, company will not be able to track design of software because design documents will not reflect the latest system.

126. Question: Is new design document created for the changes in the design resulting from the maintenance?

127. Standard: IEEE Standard 1219 has divided software maintenance into seven phases third of which is design phase. In this phase's process definition it is suggested that test cases and regression tests for the new design should be created (IEEE, 1998h).

127. Objective: This question firstly verifies compliance to IEEE Standard 1219. Moreover, it aims to check test efforts performed by the

company that result from the new design. First of the test efforts should be creating regression test cases. Because regression testing is a special type of test which aims to uncover bugs which formerly worked without problem but should be retested as a consequence of program changes. Possible outcome of not creating and running regression test cases is to dismiss bugs that result from maintenance.

127. Question: Are test cases for regression testing created for the new design resulting from the maintenance? (If maintenance causes a redesign effort)

128. Standard: IEEE Standard 1219 has divided software maintenance into seven phases fourth of which is implementation phase where change in the source code is performed during maintenance process. Coding and unit testing sub activity of implementation phase states that after change in the source code is completed unit tests should be performed by the authors of the change (IEEE, 1998h).

128. Objective: Further than verifying compliance to IEEE Standard 1219, this question checks if the company's development personnel perform execution of unit tests after implementing the software maintenance on the source code or software components. Unit testing is a major process of system development that enables early detection and correction of problems resulting from the fresh development. Moreover, unit testing allows organizations to focus on product feature and system testing instead of dealing with the bugs that blocks testing process.

128. Question: Is unit testing performed and documented after coding for the maintenance? Are the results of the unit testing documented?

129. Standard: IEEE Standard 1219 has divided software maintenance into seven phases fourth of which is implementation phase where change in the source code is performed during maintenance process. Integration sub activity of implementation phase states that after changing the source code for maintenance, integration tests should be performed by integrating the modified software with the system (IEEE, 1998h).

129. Objective: In addition to verifying compliance to IEEE Standard 1219, this question intends to analyze if company performs another loop of integration testing if the maintenance causes a significant change in the software design. Integration testing is a crucial part of the system development process since it provides a result in the compatibility of the software components with other system components and other systems.

129. Question: Is integration testing performed and documented after coding for the maintenance by integrating the modified software with the system?

130. Standard: IEEE Standard 1219 has divided software maintenance into seven phases sixth of which is acceptance test phase where software maintenance with a new design and implementation is accepted by the users of the system. An input for this acceptance process is acceptance test plans which are updated at the analysis, design and implementation phases (IEEE, 1998h).

130. Objective: First of all, this question verifies compliance to IEEE Standard 1219. This question also checks if the company keeps up-to-date acceptance test plans as a consequence of design changes resulting from

maintenance. This issue is important in the process where system should be validated with new test cases as a result of design changes.

130. Question: Is acceptance test plan updated with respect to the new design?

131. Standard: IEEE Standard 1219 has divided software maintenance into seven phases fifth of which is system testing phase. This phase suggests that system testing should be performed on the modified and fully integrated system. Standard also guides that results of the test should be reported in the process (IEEE, 1998h).

131. Objective: After verifying compliance to IEEE Standard 1219, this question intends to check if the company performs system testing on fully integrated system within the maintenance process and documents the results of system testing. System testing is critical in the maintenance process since it provides detailed outputs on system functions, user interfaces and bugs caused by the maintenance. Moreover, documentation and reporting of the results is important in the way that it allows reference in case of problems in the future and an overall evaluation of maintenance is possible with the reporting of system testing results.

131. Question: Is system testing performed for the maintenance? Are the results of the system testing documented and reported?

132. Standard: IEEE Standard 1219 has divided software maintenance into seven phases sixth of which is acceptance test phase where software maintenance with a new design and implementation is accepted by the users of the system. This standard indicates that acceptance test should

be performed on a fully integrated system and results of the acceptance test should be reported (IEEE, 1998h).

132. Objective: This question verifies compliance to IEEE Standard 1219 and checks if the company performs user acceptance testing after implementation of maintenance on the system. Customer acceptance is a critical step in the process since it allows an agreement between the customer and development groups indicating that system is maintained with respect to customer requirements and customer accepts the modification in return.

132. Question: Is acceptance testing performed for the maintenance by the users of the system? Are the results of the acceptance testing reported/retained under SCM?

133. Standard: IEEE Standard 1219 has divided software maintenance into seven phases seventh of which is delivery phase which deals with delivery of the modified system to its user. In the process description of this phase it is suggested that current working system should be backed up in order to revert back in case of a failure (IEEE, 1998h).

133. Objective: Further than verifying compliance to IEEE Standard 1219, this question intends to check company's approach in terms of backup that should be taken prior to installing the modified system. This operation is a preventive control to be used if modified system does not work properly in the production environment.

133. Question: Is a backup of the working system taken before installing the maintained new system?

134. Standard: IEEE Standard 1219 has divided software maintenance into seven phases seventh of which is delivery phase which deals with delivery of the modified system to its user. In the process description of this phase it is suggested to perform training in the customer facility following the installation of maintenance (IEEE, 1998h).

134. Objective: First of all this question verifies compliance to IEEE Standard 1219. Furthermore, it checks if the company has a practice related to retrain the system users as a result of a significant maintenance. This issue is critical along the system development process since it allows faster user adaptation and less resistance to the modified system.

134. Question: Is training provided to system users when the modifications result in significant documentation and system changes?

135. Standard: IEEE/EIA Standard 12207.0 divides primary software life cycle processes into five phases fifth of which is the maintenance process. In the maintenance review/acceptance sub process of this phase it is suggested that maintainer should obtain approval for satisfactory completion of maintenance from the system users (IEEE& EIA, 1996).

135. Objective: Further than verifying compliance to IEEE/EIA Standard 12207.0 this question checks if the company receives an approval from the customer regarding the satisfactory completion of maintenance. This issue should take place between testing of maintenance and migration to production to agree with the business units on the modification.

135. Question: Does the maintainer obtain approval for the satisfactory completion of the maintenance?

136. Standard: ISO/IEC Standard 14764 and IEEE Standard 14764 divide maintenance process into six phases fifth of which is migration. This phase has an activity called post-operation review which suggests that impact of change to the environment should be assessed in the maintenance process (ISO& IEC& IEEE, 2006b).

136. Objective: Further than verifying compliance to IEEE Standard 1219, this question intends to check if the company performs a post-operation review for the maintenance to monitor potential risks that might occur in the system. This activity is critical part of maintenance process because it allows to identify problems in the new environment earlier and to take corrective actions beforehand.

136. Question: Does the maintainer perform a post-operation review to assess the impact of the change to the new environment?

137. Standard: IEEE/EIA Standard 12207.2 defines eight supporting life cycle processes further than five primary software life cycle processes. Fourth of these supporting life cycle processes is Verification process and second activity of Verification process is Process verification which suggests that it should be verified that selected processes for project life cycle are executed and implemented (IEEE& EIA, 1997).

137. Objective: After verifying compliance to IEEE/EIA Standard 12207.2, this question aims to check if company verifies or controls that defined system development process is being executed properly in company's practices. Therefore, company should verify process compliance by reviews and controls throughout the system development life cycle.

137. Question: How does the company ensure that company's practices comply with defined system development process for the projects?

138. Standard: In IEEE Standard 1028's management preparation section, it is suggested that managers should ensure that reviews are performed as required by existing policies for both management and technical reviews (IEEE, 1997).

138. Objective: In addition to verifying compliance to IEEE Standard 1028, this question checks if the company has established and published policies for managerial and technical reviews which indicate company's general decisions to be implemented by related procedures regarding management and technical reviews. This is critical in the process to set a direction for these reviews and define the principles to be accepted throughout these reviews.

138. Question: Does the company have a review policy for management and technical reviews?

139. Standard: IEEE Standard 1028's management preparation section suggests that managers should ensure that reviews are performed as required by existing company procedures for both technical and managerial reviews (IEEE, 1997).

139. Objective: After verifying compliance to IEEE Standard 1028, this question checks if the company has established and published procedures for managerial and technical reviews which indicate step by step actions and detailed implementation actions to be taken during these reviews. Moreover, procedures provide detailed guidance for the actors,

allow standardization within the companies and enable easier follow-up for the operations including management and technical reviews.

139. Question: Does the company have technical and management review procedures?

140. Standard: IEEE Standard 1028 defines five types of reviews one of which is management review. Standard defines aim of management review as to monitor progress, determine the status of plans and schedules, confirm requirements and their system allocation, or evaluate the effectiveness of management approaches used to achieve fitness for purpose (IEEE, 1997).

140. Objective: Further than verifying compliance to IEEE Standard 1028, this question has been asked to check if company performs management reviews during system development process. Management reviews are crucial in the way as they support decisions about corrective actions, changes in the allocation of resources, or changes to the scope of the project.

140. Question: Is management review taking place during system development life cycle?

141. Standard: In the management review section of IEEE Standard 1028 software products subject to management review are provided by the standard (IEEE, 1997). Standard has listed following products for management reviews:

- Anomaly reports
- Audit reports
- Back-up and recovery plans

- Contingency plans
- Customer or user representative complaints
- Disaster plans
- Hardware performance plans
- Installation plans
- Maintenance plans
- Procurement and contracting methods
- Progress reports
- Risk management plans
- Software configuration management plans
- Software project management plans
- Software quality assurance plans
- Software safety plans

141. Objective: Further than verifying compliance to IEEE Standard 1028, this question intends to check which of the software products suggested by the IEEE Standard are subject to management reviews within the organization.

141. Question: Which of the following software products are subject to management review?

142. Standard: IEEE Standard 1028 does not provide a specific authority for the management review but it defines some qualifications for management review such as having direct responsibility for the system, having technical knowledge, being qualified to evaluate the software product (IEEE, 1997).

142. Objective: This question does not have a specific compliance objective and is merely asked to gather information regarding execution of management reviews.

142. Question: Who is responsible of management review for system development projects?

143. Standard: Set of software products subject to technical review are provided in the technical review section of IEEE Standard 1028 (IEEE, 1997). Standard has provided below list of products which should be subject to technical reviews:

- Software requirements specification
- Software design description
- Software test documentation
- Software user documentation
- Maintenance manual
- System build procedures
- Installation procedures
- Release notes

143. Objective: Further than verifying compliance to IEEE Standard 1028, this question intends to check which of the software products suggested by the IEEE Standard are subject to technical reviews within the organization.

143. Question: Which software products are subject to technical review?

144. Standard: IEEE Standard 1028 does not provide a specific authority, but it defines some roles for the technical reviews such as decision maker, review leader, recorder, and technical staff (IEEE, 1997).

144. Objective: This question does not have an assessment objective and is merely asked to gather information regarding executioner of technical reviews within the organization.

144. Question: Who is responsible of technical reviews for system development projects?

145. Standard: IEEE Standard 1061 provides a framework for software quality metrics. This methodology for software quality metrics is stated to allow organizations validation of software quality requirements quantitatively. However, this standard does not mandate specific metrics to be used for the software life cycle but provides a framework for metrics definition process. Instead of that, standard indicates that in order to assess software quality, proper metrics should be defined according to desired software quality attributes (IEEE, 1998e).

145. Objective: First of all, this question verifies compliance to IEEE Standard 1061. Moreover, it intends to check if company creates software quality metrics to reduce subjectivity in the assessment and control of software quality. Otherwise, assessment of quality is left to intuition and software quality can not be measured properly.

145. Question: Are there any software quality metrics used throughout the system development life cycle to assess software quality requirements and software deficiencies?

146. Standard: IEEE Standard 1061 provides a framework for software quality metrics. The very first step of this framework is to define software quality of a system. So, standard indicates that system quality target and requirements of an organization should be separately set for each system in the beginning (IEEE, 1998e).

146. Objective: Further than checking compliance to IEEE Standard 1061, this question checks if the organization sets a specific quality target that covers quality assurance activities. Setting realistic, measurable quality targets is a key factor of success in measuring software quality by software quality metrics.

146. Question: What is the system quality target of the organization for system development?

147. Standard: IEEE Standard 1061 provides a software quality metrics methodology. The very first step of this methodology is to establish a set of quality requirements for a system. So, standard suggests defining software quality separately for each system and breaking down each requirement to the factors that can measure it in units (IEEE, 1998e).

147. Objective: Further than verifying compliance to IEEE Standard 1061, this question checks if the company defines quality in a set of requirements for each system. This method is a crucial factor of success in measuring software quality by software quality metrics.

147. Question: How does the organization define software quality?

148. Standard: IEEE Standard 1028 defines five types of software reviews one of which is inspection (IEEE, 1997). Furthermore, standard

provides list of software products that should be inspected by the organizations such as:

- Software requirements specification
- Software design description
- Source code
- Software test documentation
- Software user documentation
- Maintenance manual
- System build procedures
- Installation procedures
- Release notes

148. Objective: Further than verifying compliance to IEEE Standard 1028, this question intends to check which of the software products suggested by the IEEE Standard are subject to inspection reviews within the organization.

148. Question: Are software products subject to internal inspections?

149. Standard: IEEE Standard 1028 defines five types of software review one of which is walk-through (IEEE, 1997). Furthermore, standard indicates software products on which walk-through should be performed such as

- Software requirements specification
- Software design description
- Source code
- Software test documentation
- Software user documentation

- Maintenance manual
- System build procedures
- Installation procedures
- Release notes

149. Objective: This question firstly verifies compliance to IEEE Standard 1028 and intends to check which of the software products suggested by the IEEE Standard 1028 are subject to walk-through reviews within the organization.

149. Question: Are software products subject to walk-through?

150. Standard: IEEE Standard 1074 divides software project life cycle into five activity groups fifth of which is Support Section of Activity Groups. A sub process of this activity defines post-implementation review as the last type of review to be implemented throughout the project life cycle (IEEE, 2006a). Standard also defines post-implementation review as comparison of all planning information with the actual results to determine any improvements needed in such areas as resource utilization, return on investment, and quality system.

150. Objective: In addition to verifying compliance to IEEE Standard 1074, this question intends to check if company performs a post-implementation review in order to compare plans and actual results, define the degree of success from the project, and compare actual costs and benefits against the budget.

150. Question: Is post implementation review performed by the organization?

151. Standard: IEEE/EIA Standard 12207.2 suggests several dimensions of verification that can be used throughout the system development life cycle such as contract verification, process verification, requirements verification and design verification. Standard also provides detailed guidelines related to these several verification categories (IEEE& EIA, 1997).

151. Objective: After verifying compliance to IEEE/EIA Standard 12207.2, this question intends to check if company performs a verification process to determine whether the software products of an activity fulfill the requirements or conditions imposed on them in the previous activities. So, all the detailed verification types and sub processes provided by the standard are asked to the target companies. Verification process is a critical indicator of contract, process, requirements, and design success.

151. Question: Does the company employ a verification process?

CHAPTER FIVE

SITUATION AND PROBLEMS

This chapter is the core part of this study and it performs a comparison between banks' current status and expected status with respect to IEEE Software Engineering Standards.

As an important interpretation of results, it is worth to mention that interviews with the banks took place between September 2007 and January 2008. So, results and problems identified are reflection of process conditions as of these time intervals and subject to changes due to evolving nature of companies' system development processes.

As the structure of the chapter, it firstly provides expected situation which is generated from IEEE Standards question by question and later discusses current situation of banks. If there is a problem related to compliance to the standard or process, a problem definition is created following each question.

Expected Situation: This question intends to give an introduction about the scale of projects managed at the banks.

1. Question: What are the characteristics of the projects being managed in terms of scale?

Current status of Bank A: Projects are classified according to resource requirements. Projects that require higher resources than 150 men/day are sent to IT Committee for approval. Projects that require resources

between forty men/ day and 150 men/ day are handled using normal project management methodology of the organization without getting approval from the IT Committee. Moreover, projects that require fewer resources than forty man/ day are taken into consideration as maintenance projects.

Current status of Bank B: Project scales are classified according to project duration and risk evaluation performed by the company and named as A, B, C type projects. A represents large project, B represents medium scale project, and C represent small scale projects. According to this grouping project processes are differentiated and projects are managed according to these small differentiations.

Current status of Bank C: Bank C also classifies scale of projects according to resource allocation. Projects that require fewer resources than thirty man/ day are called as small scale projects. However, when impact analysis of a project requires more resources than thirty man/ day, it is classified as large scale project by Bank C. CMMI efforts that company deals with is stated to bring medium scale projects in terms of project scale classification.

Expected Situation: This question provides information about requirement characteristics of projects managed at the banks.

2. Question: What are the characteristics of the projects being managed in terms of budget and requirements?

Current status of Bank A: Although it is changing most of the time, Bank A's information systems projects generally have concrete requirements. It is assumed by the organization that at the end of analysis

phase, analysis documents will remain same and unchanged due to requirement changes in the project.

Current status of Bank B: Although there is not a certain metric, Bank B approximately manages information systems projects with %50 fast-changing requirements and %50 concrete requirements.

Current status of Bank C: Although there is not a certain metric, Bank C approximately manages information systems projects with %50 fast-changing requirements and %50 concrete requirements.

Expected Situation: IEEE Standard 1058 lists down all the managerial process plans that should be created by the organization that manages the software project such as estimation, staffing, staff training, work activities, resource allocation, budget allocation, requirements control plan, schedule control plan, budget control plan, quality control plan, reporting plan, risk management plan and closeout plan (IEEE, 1998a).

3. Question: Are software project management plans created for the software projects?

Current status of Bank A: Bank A creates estimation, staffing, staff training, work activities, resource allocation, schedule control, budget allocation, budget control, reporting, and risk management plans for the projects. Bank A performs budget allocation plans yearly, where business units enter budget requirements and get approvals for their budget requirements. Bank A also periodically reports projects status at each two weeks to stakeholders and at each month to project orientation committee. However, requirements control plan, quality control plan, closeout plan are not created for information systems projects by Bank A.

Current status of Bank B: Bank B creates estimation, staffing, staff training, work activities, resource allocation, schedule control, quality control, reporting, risk management, closeout plan for system development projects. But, budget allocation and requirements control plan are not created by Bank B for system development projects.

Current status of Bank C: Bank C generates staffing, work activities, resource allocation, budget allocation, requirements control, schedule control, budget control, reporting plans. However, rest of the plans such as estimation plan, quality control, and risk management plan are stated to be prepared with CMMI process works carried out by Bank C.

Problem: Managerial process plans advised by IEEE Standard 1058 are not created completely by all banks. Requirements control plan, quality control plan, closeout plan are not created for information systems projects by Bank A. Budget allocation and requirements control plan are not created by Bank B and estimation plan, quality control, and risk management plan are not created by Bank C.

Expected Situation: IEEE Standard 1058 explains that as project plans get more detailed during the project's life cycle they should be maintained under configuration management with versions (IEEE, 1998a).

4. Question: How is the project management plan maintained through the life cycle of the project?

Current status of Bank A: Project Managers at Bank A maintain project plan on Microsoft Word application by giving version names to the documents as documents change in the project management process. Documents are stored at a server in the bank's network. But, Bank A plans

to purchase an application for project management in 2008. Project managers are responsible of maintaining project management plans manually in Bank A.

Current status of Bank B: Bank B uses a project management application that executes the whole system development and project management process. Moreover, project management plans are versioned and changes on the plans are based on change records opened by project stakeholders. Project management plans are under the control of project managers and quality control staff within the organization. These roles continuously monitor deviations of project activities and update the plan when required.

Current status of Bank C: Project manager prepares project plan and project schedule in collaboration with project team at Bank C. Besides, Bank C currently does not have a configuration management system to retain and follow up project management plans. Bank C has stated that project plan and schedules will be managed with configuration management guidelines of CMMI model in the future.

Problem: Bank A and Bank C's project management plans are not managed by a formal configuration management approach as stated in IEEE Standard 1058.

Expected Situation: IEEE Standard 1058 indicates that metrics, reporting mechanisms, and control procedures necessary to measure, report, and control the product requirements, the project schedule, budget, and resources, and the quality of work processes and work products should be specified within the plan (IEEE, 1998a).

5. Question: Is a project control plan created? Which of the following are specified within the plan?

Current status of Bank A: None of the project control plans provided with the question are prepared by Bank A.

Current status of Bank B: None of the project control plans provided with the question are prepared by Bank B. But, Bank B currently works on a process named Measure and Analyze which is under construction and covers project control plan mentioned in this question.

Current status of Bank C: None of the project control plans provided with the question are prepared by Bank C. But, it is stated that current CMMI process efforts in the company will cover all aspects of this question.

Problem: None of three banks create project control plan suggested by IEEE Standard 1058 that covers metrics, reporting mechanisms, and control procedures necessary to measure, report, and control the product requirements, the project schedule, budget, and resources.

Expected Situation: IEEE Standard 1074 suggests that project progress should be reviewed and measured against established and estimated plans (IEEE, 2006a).

6. Question: Is the progress of the project reviewed and measured in terms of estimated and actual plans?

Current status of Bank A: Bank A performs progress estimation with %75 precision at baseline project plans during the project kick-off phase and budget oriented estimation with %25 precision at the end of analysis and design phase. These estimations are continuously monitored at the project status reports.

Current status of Bank B: Bank B does not have an active project progress measurement process. But, project management tool used by Bank B is capable of providing such measurement data for project progress.

Current status of Bank C: Bank C does not have an active project progress measurement process but it is planned to deploy such processes with current CMMI process improvement efforts carried out by the company using measurement metrics.

Problem: Bank B and Bank C are not measuring and reviewing the project progress using estimated plans and actual results as suggested by IEEE Standard 1074.

Expected Situation: IEEE Standard 1058 includes risk management plan in the managerial processes of project management. Risk management plan's objective, usage, necessity and utilization during project life cycle are explained in the standard (IEEE, 1998a). So, companies should prepare risk management plan in order to handle and manage risks of information systems projects.

7. Question: Is there a risk management plan within the software project plan for identifying, analyzing, and prioritizing project risk factors?

Current status of Bank A: Bank A prepares risk management plans by filling out risk evaluation forms for each information system development project. Risk values of a project are found by multiplying risk's probability and effect in the process and risks are monitored with respect to risk values throughout the project.

Current status of Bank B: Bank B also prepares risk management plans to identify and follow up risks for information systems projects.

Current status of Bank C: Bank C currently does not prepare risk management plans to manage risks that occur within information systems projects.

Problem: Bank C does not perform risk planning for information systems projects which is suggested by IEEE Standard 1058.

Expected Situation: According to suggestions of IEEE Standard 1058, technical process plans should include development process model, technical methods, tools, and techniques to be used to develop the various work products (IEEE, 1998a).

8. Question: Is there technical process plan created in the software project plan?

Current status of Bank A: Technical process plans are created by Software Development and System Development departments at Bank A and Project Managers are only responsible of following up start and end dates of technical processes. Technical process plans cover project infrastructure plan and product acceptance plan in Bank A. But plan does not include specification of development process model, technical methods, tools and techniques for technical processes.

Current status of Bank B: Bank B also prepares technical process plans for system development processes covering all aspects that are provided by IEEE standard 1058.

Current status of Bank C: Bank C currently does not prepare technical process plans in software project plans. But it is stated all the issues addressed by IEEE Standard 1058 in this question will be performed

after completion of the CMMI improvements currently carried out by the company.

Problem: Technical process plans advised by IEEE Standard 1058 are not completely created by Bank A and Bank C. Specification of development process model, technical methods, tools and techniques in the technical process plans are not performed by Bank A. In addition to that, none of the issues specified by IEEE Standard 1058 are prepared by Bank C in the technical process plans.

Expected Situation: IEEE Standard 1058 suggests that subcontractor management plans should exist and include requirements management, monitoring of technical progress, schedule and budget control, product acceptance criteria, and risk management procedures (IEEE, 1998a).

9. Question: Is subcontractor management plan created in the software project plan for selecting and managing any subcontractors that may contribute work products to the software project?

Current status of Bank A: Activities that are related to subcontractors are created as sub tasks in the main project plan at Bank A.

Current status of Bank B: If there is a concern of subcontracting, Bank B prepares supply management plan to manage subcontracting process.

Current status of Bank C: Subcontractor management plans are not prepared by Bank C to manage the subcontracting process. But, it is stated that current CMMI process improvements of the company will enforce preparation of such plans.

Problem: Bank C does not prepare subcontractor management plans within the software project plan as suggested by IEEE Standard 1058.

Expected Situation: IEEE Standard 1058 indicates that subcontractor selection criteria should be defined within the subcontractor management plan (IEEE, 1998a).

10. Question: Are criteria for selecting subcontractors specified in the subcontractor management plan?

Current status of Bank A: Bank A has a specific process to select subcontractors. Firstly, company receives proposals from at least three vendors and evaluation criteria are defined on a project basis. Afterwards, a shortlist indicating candidate suppliers is sent to IT purchasing department by IT project managers. Supplier selection criteria reside in the project plan as a sub activity to be performed in the project.

Current status of Bank B: Supplier selection criteria are not included in the supply management plan at Bank B. Rather than that, supply management plan includes activities and tasks to define project specific supplier selection criteria.

Current status of Bank C: As subcontractor management plan is not prepared by Bank C, subcontractor selection criteria is not documented for information systems projects.

Problem: Subcontractor selection criteria are not specified in the subcontractor management plan at Bank B and Bank C as suggested by IEEE Standard 1058.

Expected Situation: IEEE Standard 1074 suggests that training plan and documentation plans should be created at the software project's planning phase (IEEE, 2006a).

11. Question: Are documentation and training plans created for system development projects?

Current status of Bank A: Bank A performs planning related to documentation and training in project management plans.

Current status of Bank B: Bank B does not prepare separate plans for documentation within project plans. Instead, defined processes indicate where to start which type of documentation. However, training plans for information systems projects are created within project plans at Bank B.

Current status of Bank C: Documentation and training plans are not placed in the project management plans on a regular basis at Bank C. But, it is stated that project plan that is being prepared with current CMMI process improvements covers documentation and training plans.

Problem: Bank B does not create documentation plans as suggested by IEEE Standard 1074.

Problem: Bank C does not create documentation and training plans as suggested by IEEE Standard 1074.

Expected Situation: IEEE Standard 1074 suggests that project records should be collected from activity groups and used for future project planning by the organizations (IEEE, 2006a).

12. Question: Are project records collected and retained from all activity groups at the close-out?

Current status of Bank A: In accordance with quality principles of Bank A, project records and documents are stored at a single folder. Quality assurance personnel checks project folders and follow up missing required documents and records for information systems projects.

Current status of Bank B: Projects records are electronically stored at the project management tool used by the company.

Current status of Bank C: Project records and documents are also stored at a single folder at Bank C. However, it was stated that after completion of CMMI process improvements carried out by the company, project risks, lessons learned, project metrics will be stored at organizational databases.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 1540 suggests that risk management policy should be explicitly defined and provides what the policies should contain in order to perform an effective risk management for system development projects. Moreover, standard indicates that there should be a defined process for risk management that is governed with risk management policies (IEEE, 2001a).

13. Question: Has the company defined risk management policies/procedures for system development projects?

Current status of Bank A: Bank A has documented its risk management process and established procedures to execute risk management process.

Current status of Bank B: Bank B has documented its risk management process and established procedures to execute risk

management process. Moreover, project manager of each project is directly responsible of executing defined risk management process.

Current status of Bank C: Bank C has documented its risk management process and established procedures to execute risk management process. Process definitions include methods for risk identification, risk evaluation parameters, risk monitoring, urgent matters and action planning, risk database.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 1540 suggests that risk management process should be documented and promulgated along the process (IEEE, 2001a). Furthermore, process defines what a risk management procedure consistent with the process should include related to risks including:

- The frequency at which risks are to be reanalyzed and monitored,
- The type of risk analysis required (quantitative and/or qualitative),
- The scales to be used to estimate risk likelihood and consequences and their descriptive and measurement uncertainty,
- The types of risk thresholds to be used,
- The types of measures used to track and monitor the state of the risks,
- How risks are to be prioritized for treatment,

- Which stakeholder(s) perspectives the risk management process supports,
- The risk categories to be considered.

14. Question: Which aspects of the risk management process are created/ documented?

Current status of Bank A: Bank A has documented all of the aspects provided by IEEE Standard 1540 except type of risk analysis required and which stakeholder perspectives are supported by risk management process.

Current status of Bank B: Bank A has documented all of the aspects provided by IEEE Standard 1540.

Current status of Bank C: Bank C has documented all of the aspects provided by IEEE Standard 1540 except type of risk analysis required.

Problem: Bank A and Bank C have not documented types of risk analysis required in the risk management process as suggested by IEEE Standard 1540.

Problem: Stakeholder perspectives supported by the risk management process are not documented within the risk management process by Bank A as suggested by IEEE Standard 1540.

Expected Situation: IEEE Standard 1540 suggests that risk thresholds should be defined for individual risks or combination of risks in system development projects (IEEE, 2001a).

15. Question: Does the company define risk thresholds for the projects? For what aspects thresholds are set by the company?

Current status of Bank A: Bank A fills out risk evaluation forms for each information system development project and each risk. Risk values of

a project are found by multiplying risk's probability and effect in the process and risks are monitored with respect to risk values throughout the project. Also risk thresholds are set for each risk by Bank A. Risk guidelines of Bank A provide precautions to be taken according to risk values. Moreover, project managers evaluate risks and fill out security evaluation forms which are further monitored by risk management personnel.

Current status of Bank B: Bank B defines risk thresholds for each system development project on a risk basis.

Current status of Bank C: Bank C defines risk thresholds for each system development project in accordance with risk probability and impact of risk.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 1540 suggests that project risk profile should be established and maintained to be used throughout the project life cycle for each project (IEEE, 2001a). Moreover, standard lists minimum components of a project risk profile as following:

- The risk management context
- A chronological record of each risk's state including their likelihoods, consequences, and risk thresholds
- The priority ordering of each risk based on criteria supplied by the stakeholders
- The risk action requests for risks along with the status of their treatment

16. Question: Does the company create risk profile for the projects?

Current status of Bank A: Bank A creates all aspects of project risk profile as suggested by IEEE Standard 1540.

Current status of Bank B: Bank B creates all aspects of project risk profile as suggested by IEEE Standard 1540 except chronological record of each risk's state. It was stated that Bank B only keeps record of current risk status.

Current status of Bank C: Bank C creates all aspects of project risk profile as suggested by IEEE Standard 1540.

Problem: Bank B does not keep chronological record of each risk's state as suggested by IEEE Standard 1540.

Expected Situation: IEEE Standard 1540 emphasizes that project's risk profile should be periodically communicated to project's stakeholders based upon their requirements (IEEE, 2001a).

17. Question: At which frequency project's risk profile or relevant risk profile (e.g., a single or combination of risks) is communicated to stakeholders?

Current status of Bank A: Project's risk profile is shared with the stakeholders at the project kick-off and before migration to production at Bank A. Moreover, project status report which is periodically updated is shared with project stakeholders.

Current status of Bank B: Bank B prepares project communication plan on a project basis and stakeholders receive risk based information according to that communication plan.

Current status of Bank C: Bank C has periodic weekly project meetings where latest status of project risks are updated and communicated to stakeholders.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 1540 suggests that system development project's risks should be analyzed in the sequence of identification, estimation and evaluation phases. Standard suggests a continuous risk analysis throughout the software life cycle and states that various techniques such as risk questionnaires, taxonomies, brainstorming, scenario analysis, lessons learned, and prototyping can be used to identify the risks (IEEE, 2001a). Later on, in the risk estimation phase, the likelihood of occurrence and consequences of each risk identified shall be estimated. Finally, standard suggests that each risk should be evaluated against its risk thresholds. Risks should be evaluated independently, in combination, and along with their interactions with system and enterprise risks. Risks should be evaluated against the project risk threshold to assure that a combination of risks, while below their individual thresholds, does not unacceptably place the project as a whole at risk.

18. Question: Does the company perform risk analysis throughout the system development life cycle to identify, estimate and evaluate risks? How are the risks evaluated at the end? What are the evaluation parameters?

Current status of Bank A: Bank A has established its own risk analysis criteria and performs risk analysis using those criteria for system development projects. Moreover, risks are evaluated with respect to risk

thresholds calculated in risk evaluation forms prepared by project managers in the company.

Current status of Bank B: Bank B performs risk analysis throughout the system development life cycle. After identification of risks in the project meetings, their probability of realization and impact to project is estimated. Risk analysis and prioritization are performed with respect to the multiplication of probability of realization and impact to project.

Current status of Bank C: Bank C also performs risk analysis with respect to CMMI for system development projects. Risks are identified using risk identification checklist, project members' experiences, and past project experiences. Importance of the risk is calculated by multiplying impact and probability and risks are analyzed with respect to those importance values.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 1540 suggests that risks and risk treatment should be continuously monitored and recorded in the risk profile (IEEE, 2001a). Furthermore, standard emphasizes that results of risk monitoring should be reported to project stakeholders.

19. Question: Does the company monitor risks for changes in their state using measures? Is the monitoring recorded in the project risk profile? Who is responsible of risk monitoring? Is reporting performed after monitoring process?

Current status of Bank A: Project risks are recorded in the project status reports by project managers at Bank A. Project managers also assign responsible peers for each risk and define a date for resolution of risk. After

that, project manager follows up resolution and status of risk at each two weeks. However, results of risk monitoring process are not reported to project stakeholders at Bank A.

Current status of Bank B: Bank B monitors changes of risk states and records all the progress and changes to project management tool. Project managers are responsible of risk monitoring at Bank B. However, results of risk monitoring process are not reported to project stakeholders at Bank B.

Current status of Bank C: Bank C also monitors changes in the risk states and results of risk monitoring are recorded at project records. Project risk manager is responsible of risk monitoring process and results of this process are reported to project stakeholders.

Problem: Results of risk monitoring process are not reported to project stakeholders as advised by IEEE Standard 1540 at Bank A and Bank B.

Expected Situation: IEEE Standard 1540 suggests that whole process for risk management should be examined for its efficiency and deficiencies (IEEE, 2001a). Standard lists out purposes of evaluation to provide feedback stakeholders regarding:

- The quality of the risk management process
- Areas where the risk management procedures, process, or policies should be improved
- The identification of opportunities for modifying organizational risk management procedures, processes, or policies to better reduce or eliminate systemic risks.

20. Question: How does the company evaluate its risk management process? Who performs the evaluation of risk management process?

Current status of Bank A: Evaluation of risk management process for its efficiency and deficiencies is not performed by Bank A.

Current status of Bank B: Quality Assurance unit at Bank B performs evaluation of risk management process as all other processes in use at the bank. Moreover, results of the evaluation are reported to executive management for review.

Current status of Bank C: Evaluation of risk management process is currently performed within the CMMI project of Bank C. Moreover, required enhancements to the process are being defined and implemented with CMMI project.

Problem: Evaluation of risk management process for its efficiency and deficiencies is not performed by Bank A as suggested by IEEE Standard 1540.

Expected Situation: There is no expected situation for this question.

21. Question: Is there a system development process management framework used by the company? (ITIL, CoBIT, CMM)

Current status of Bank A: Bank A utilizes ITIL, CoBit, CMMI and Project Management Institute (PMI) Project Management Methodology for process and project management.

Current status of Bank B: Bank B has adopted its system development process with respect to CMMI level three.

Current status of Bank C: Bank C uses Service Management System for process management which is based on ITIL and CoBit frameworks.

Problem: This question has solely been asked to gather information related to the usage of process management frameworks within the banks.

Expected Situation: This question aims to perform an analysis using literature review performed on system development methodologies. Due to the literature review, it was found that some methodologies are more suitable for some type of requirements and projects. So, this question will result in an analysis between company's software requirement types, system development methodology and project characteristics.

22. Question: Is there a system development methodology used in the organization?

Current status of Bank A: Bank A mainly uses classical Waterfall model for system development. However, as it takes too long to develop and deploy projects with this model Bank A is considering and working to use Agile Development methodologies.

Waterfall method is rather suited for routine types of projects where the requirements are well defined (Khalifa& Verner, 2000) and requirement types of Bank A are generally concrete. So, this methodology shows a proper fit with the bank's requirements. However, Agile models are hard to apply to large scale projects due to its lack of architecture planning and overfocus on early results (Fruhling & Tyser& Vreede, 2005). So, Bank A has to ponder scale of projects when implementing Agile methodologies.

Current status of Bank B: Bank B has established its own system development methodology using CMMI and PMI processes.

Current status of Bank C: Waterfall model is the main system development methodology used by Bank C. As Waterfall method is rather

suited for routine types of projects where the requirements are well defined (Khalifa& Verner, 2000) and requirement types of Bank C are %50 concrete, Bank C has to consider tailoring Waterfall methodology or, changing the nature of %50 requirements from fast-changing to concrete.

Problem: Bank A has to ponder scale of projects when implementing agile methodologies as agile models are hard to apply to large scale projects because of its lack of architecture planning and over-focus on early results.

Problem: Bank C has to consider tailoring Waterfall methodology or, changing the nature of %50 requirements from fast-changing to concrete for project success. Because Waterfall method is rather suited for concrete requirements and requirement types of Bank C are %50 concrete.

Expected Situation: An underlying reason for information systems success is a tailored methodology. Due to this reason, this question checks whether the company has tailored a known system development methodology or not for system development projects.

23. Question: Has the company tailored the system development methodology?

Current status of Bank A: Bank A uses several aspects of Waterfall methodology which complies with project management methodology of the organization. When there is a guideline provided by Waterfall model that is not compliant with the project management methodology, it is not used by Bank A. So, there is an abstract level of customization for Waterfall model by Bank A.

Current status of Bank B: System development methodology used at Bank A is extracted from PMI and CMMI processes and it is tailored to fit organization's needs.

Current status of Bank C: Bank C has also tailored Waterfall methodology with respect to organizational needs. For example, technical design can start when major issues of analysis phase are completed at Bank C which is against the guidelines of Waterfall model. But, in order to complete technical design it is asked to have a complete analysis phase. Moreover, unit testing process can be executed simultaneously with development process, where only finished parts of development are unit tested in Bank C.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 1062 suggests that an organization should first plan software acquisition and then turn the planning into an organizational software acquisition strategy (IEEE, 1998b). Moreover, standard suggests that strategy should include:

- List of capabilities to identify potential suppliers,
- Identification of responsibilities of acquirer and the supplier,
- Extent of supplier's organizational involvement to provide the quality product,
- Identification of responsibilities that are best handled by the acquirer's organization,
- Identification of responsibilities to include in the contract and to be negotiated with the supplier.

24. Question: Does the company have a software acquisition strategy for acquiring off-the-shelf products?

Current status of Bank A: Bank A currently does not have a software acquisition strategy for acquiring off-the-shelf products.

Current status of Bank B: Bank B's software acquisition strategy exists and it is defined in the supplier management process of the company.

Current status of Bank C: Bank C currently does not have a software acquisition strategy for acquiring off-the-shelf products. But, it has been stated that this issue will be taken into consideration in the current CMMI process improvement efforts.

Problem: Bank A and Bank C don't have a software acquisition strategy for acquiring off-the-shelf products as suggested by IEEE Standard 1062.

Expected Situation: IEEE standard 1074 suggests that an analysis of idea or need should be performed which includes potential approaches and all life time benefits of the need. Furthermore, sub process suggests that feasibility study can also be used to make the make or buy decision (IEEE, 2006a).

25. Question: Is feasibility study conducted at the beginning of the system development project? Who is the responsible unit of the feasibility study?

Current status of Bank A: Feasibility study is performed by business units that generate the business requirements at Bank A.

Current status of Bank B: Bank B expects the business unit that requests the project to perform a feasibility study. It has been stated that feasibility studies are not performed as expected at Bank B.

Current status of Bank C: Feasibility study is performed by business development unit or business analysis unit at Bank C. However, it is acceptable to collaborate with business units in the preparation of feasibility study.

Problem: Feasibility study is not performed by Bank B covering all corporate feasibility requirements as suggested by IEEE Standard 1074.

Expected Situation: IEEE standard 1074 suggests that an analysis of idea or need should be performed which includes potential approaches and all life time benefits of the need. Furthermore, sub process suggests that feasibility study can also be used to make the make or buy decision (IEEE, 2006a).

26. Question: What are the dimensions of feasibility study? What are the methods of feasibility study? How does the company make the go decision?

Current status of Bank A: Bank A performs feasibility study in the dimensions of time, operational feasibility and cost. Operational feasibility corresponds to efficiency such as numerical savings gained such as resources by implementing the project. IT committee of Bank A, made up of assistant general managers, scores all of the system development projects and projects that receive a certain score are implemented at Bank A.

Current status of Bank B: Bank B does not have a defined feasibility study method. Firstly, Bank B prepares a yearly master plan for system

development projects and all business units forward their requests to software development unit at Bank B. Finally, software development unit gets requests into yearly master plan with respect to development resources on hand and the priority of the requests. To sum up, Bank B aims to implement all business needs.

Current status of Bank C: Bank C prepares scope documents that include time, operational, cost and user feasibility as well as objectives and risks for system development projects. Afterwards, this document is presented to technical committee of the bank and committee decides to start or cancel the project. Technical committee is composed of general managers and unit managers at Bank C.

Problem: No problem identified for this question.

Expected Situation: IEEE Standard 1074 suggests that each recommended practice in the feasibility study should formally be approved by concerned organizations such as user and the developer (IEEE, 2006a).

27. Question: Who approves the result of feasibility study?

Current status of Bank A: IT committee that is composed of assistant general managers approves results of feasibility study at Bank A.

Current status of Bank B: Business sponsor approves the results of feasibility study at Bank B.

Current status of Bank C: Technical committee and business sponsor approves the results of feasibility study together at Bank C.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 1233 provides several methods and approaches to define system and software requirements. It is mentioned

that whole process can be undertaken by the customer, while customer interacts with the analysts for assistance in another approach. In addition to that, standard provides several techniques to identify requirements such as workshops, brainstorming sessions, interviews, surveys, and questionnaires.

28. Question: How does the company identify requirements?

Current status of Bank A: Bank A identifies system and software requirements in two ways. Firstly, business customers send initiating documents to explain the details of the requirement. Afterwards, customer and analyst work together to translate the problem or need into a solution.

Current status of Bank B: System or software requirements are identified by collaboration of customers and analysts at Bank B. Moreover, analytical exercises and workshops are further used to define system or software requirements.

Current status of Bank C: Requirements definition is performed through several ways at Bank C including customers, customer and analysts, analyst and customer intermediaries, initiating documents, analytical exercises, and workshops. Moreover, it is stated that legal changes in the environment, technological changes enforce Bank C to perform requirements definition process.

Problem: No problem has been identifies for this question.

Expected Situation: IEEE Standard 830 indicates that SRS document may be written by one or more representatives of the supplier (an organizational unit or an outsourced firm), one or more representatives of the customer. However, standard suggests joint preparation of software requirements specifications (IEEE, 1998d).

29. Question: Are business sponsors and IT project leads involved in defining business requirements?

Current status of Bank A: IT project managers optionally attend requirements definition meetings if it is requested by analysis personnel or business end at Bank A.

Current status of Bank B: Although requirements are defined by customers and analysts at Bank B, business sponsors attend project meetings and approve defined business requirements to formalize their point of views.

Current status of Bank C: All parties that are somehow related with business requirements may be included in the decision and analysis process if necessary at Bank C.

Problem: No problem has been identified for this question.

Expected Situation: IEEE/EIA standard 12207.2 suggests that developer of the system should select a software life cycle model appropriate to the scope, magnitude and complexity of the project (IEEE& EIA, 1997).

30. Question: Does the company select a software life cycle model appropriate to the scope, magnitude, and complexity of the projects?

Current status of Bank A: Bank A has been using Waterfall model for system development. Afterwards, Bank A has observed that this model has drawbacks related to durations and resources. It has been stated that pilot application of Agile development methodologies usage has started at Bank A.

Current status of Bank B: As Bank B classifies projects according to project duration and risk evaluation performed by the company, project

processes are differentiated and projects are managed according to this classification. For example, A type projects have a higher emphasis on risk management and risk management processes are applied thoroughly in the system development process.

Current status of Bank C: It has been stated that selected software life cycle model corresponds to organization's needs for system development at Bank C.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 1074 suggests that project metrics should be created with respect to project requirements and project plans. Moreover, standard underlines that project metrics can be related to quality, process or productivity and target of the metrics to be applied are given as products of the project and the processes that affect the project (IEEE, 2006a).

31. Question: Are project metrics created for the project with respect to the project requirements, project management plan?

Current status of Bank A: Bank A has created project metrics related to project duration, and activity completion dates. Moreover, project success is measured with metrics of deviations in time, effort and scope.

Current status of Bank B: Bank B has created several project metrics on duration, workforce, cost, and completion date deviation. In addition to that, each process for system development has its own measurement at Bank B. For example, error numbers identified in the project are measured by source of the errors in the testing process.

Current status of Bank C: Bank C currently does not have project metrics to measure several aspects of project success. But, it has been stated that this issue will be taken into consideration with the current CMMI process improvements in the company.

Problem: Bank C currently does not have project metrics to measure several aspects of project success as suggested by IEEE Standard 1074.

Expected Situation: IEEE/EIA Standard 12207.0 suggests that if a supplier is retained to perform requirement analysis, the acquirer should approve analyzed requirements (IEEE& EIA, 1996).

32. Question: How does the company approve the analyzed requirements if software requirements analysis is performed by a supplier? Who approves the analysis?

Current status of Bank A: Project owner which is actually the business unit that requests the project approves outsourced requirements analysis at Bank A.

Current status of Bank B: Bank B performs a requirement review where project sponsors also join review meetings and approve analyzed requirements.

Current status of Bank C: After examining and understanding the analysis performed by the supplier in detail, Bank C gets the result of analysis work as an input to system development process as in-house projects.

Problem: Bank C does not have a formal approval process as suggested by IEEE/EIA Standard 12207.0 if software requirements analysis is performed by a supplier.

Expected Situation: IEEE Standard 830 identifies basic issues that a software requirements specification document should address such as:

- Functionality: What is the software supposed to do?
 - External interfaces: How does the software interact with people, the system's hardware, other hardware, and other software?
 - Performance: What is the speed, availability, response time, recovery time of various software functions?
 - Attributes: What are portability, correctness, maintainability, security considerations?
 - Design constraints: Are there any required standards for effect, implementation language, policies for database integrity, resource limits, and operating environments?
- (IEEE, 1998d).

33. Question: Are software requirements specification documents prepared?

Current status of Bank A: Software requirements specification documents prepared by Bank A cover all of the aspects that are provided by IEEE Standard 830 for SRS documents.

Current status of Bank B: Software requirements specification documents prepared by Bank B cover functionality, external interfaces, and design constraints as addressed by IEEE Standard 830.

Current status of Bank C: Software requirements specification documents prepared by Bank C cover all of the aspects that are provided by IEEE Standard 830 for SRS documents.

Problem: SRS documents prepared by Bank B do not cover performance and attribute issues as suggested by IEEE Standard 830.

Expected Situation: According to IEEE Standard 1233 customer is an entity, target audience of system requirement specification process and process for developing system requirement specifications includes customer feedbacks. Standard suggests that after presenting the requirements, it should be updated with respect to the feedbacks from the customer (IEEE, 1998c). Customer feedback consists of updating customer objectives, problems or needs.

34. Question: Does the company get customer feedbacks during preparation of system requirement specifications to update requirements and customer's problems? Who follows up the requirements that are triggered by the customers?

Current status of Bank A: Customer requests for changes in the system requirement specifications are handled by system development unit at Bank A. Moreover, scope changes requested by customers are performed by project management unit of the bank.

Current status of Bank B: Bank B applies its change management process to all system requirements in case of a feedback from a customer to change a requirement.

Current status of Bank C: Whenever there is a new requirement, problem or a change request by the customers for the existing requirements, business consulting unit at Bank C is responsible of following up and managing the requirement changes.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 1233 suggests that to discover changes related to system requirement specifications earlier, technical community should be included to the early stages of the process (IEEE, 1998c).

35. Question: Is the technical community included in the requirements specification phase? What is the gain that technical community brings out to the phase?

Current status of Bank A: Software development staff also joins requirements specification meetings at Bank A. Moreover, if it is requested by analysis staff, database and network staff also joins requirements meetings. Bank B follows this approach for collaboration. However, it has been stated technical staff does not interfere to the definition of the requirements most of the time in these meetings.

Current status of Bank B: Technical community is not included in the requirements specification phase at Bank B. Instead, technical community participates in the phase where business requirements are defined and project progresses to definition of software and technical requirements. Hence, technical community actively participates in the development of software requirements specification document instead of defining system and business requirements.

Current status of Bank C: Technical community evaluates scope and requirements of business requests after the request and before requirements analysis phase at Bank C.

Problem: Technical community is not included in the requirements specification phase at Bank B as suggested by IEEE Standard 1233.

Expected Situation: IEEE Standard 1233 suggests categorization of requirements on different dimensions and requirement and provides a list of possible classification aspects as following (IEEE, 1998c):

- Identification: Each requirement should be uniquely identified.
- Priority. The customer should identify the priority of each requirement.
- Criticality. The analyst, working with the customer, should define the criticality of each requirement.
- Feasibility. The customer and analyst working together should identify the feasibility of including each particular requirement in the system
- Risk. Risk analysis techniques can be used to determine a grading for system requirements.
- Source. Each requirement should be further classified by a label that indicates the originator.
- Type. Requirements can also be categorized by one or more of types such as input, output, reliability, availability, maintainability, performance, accessibility, environmental conditions, ergonomic, safety, security.

36. Question: Are customer requirements classified?

Current status of Bank A: Bank A classifies customer requirements in the dimensions of identification number, priority, criticality, feasibility, risk, and sources. Priority of a requirement is a must in the system development process of Bank A. Moreover, feasibility of each requirement

is evaluated by several parties and status and availability of resources is checked for each requirement.

Current status of Bank B: Bank A classifies customer requirements in the dimensions of identification number, priority, criticality, feasibility, and type

Current status of Bank C: Bank C does not classify customer requirements but uses dimensions provided by the standard for decisions related to implementation of requirements. Moreover, it has been stated that priorities and resources are the dimensions that show higher volatilities compared to other elements.

Problem: Bank C does not classify customer requirements as suggested by IEEE Standard 1233.

Expected Situation: IEEE standard 1233 suggests that requirements should be validated during identification of requirements (IEEE, 1998c).

37. Question: Does the company validate requirements to be designed from the set of requirements that customers demand? If yes please specify how?

Current status of Bank A: Draft user guide which corresponds to SRS documents is approved by business units at Bank A.

Current status of Bank B: System requirements are approved by business customers using official documents, meetings, or e-mails. One of these methods is chosen at Bank B according to risk size of the project.

Current status of Bank C: Bank C consolidates business requirements and performs a feasibility study on the requirements. After, performing a scope presentation to the technical community that includes

requirements, community decides to continue to the design phase for system development projects.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 830 suggests that there should be a formal change process to track and control changes on SRS documents (IEEE, 1998d).

38. Question: How are the changes occurring during the project reflected to SRS documents? Is there a formal change process for changing requirements which allows retaining up-to-date SRS documents?

Current status of Bank A: Changes on SRS documents during a system development project is tracked using revision records that are created in these documents at Bank A. Revision records include information such as date of change, explanation of change, and creator of change.

Current status of Bank B: Bank B has a defined requirements change process that covers changes on SRS documents.

Current status of Bank C: Bank C keeps versions of SRS documents and updates the documents. Moreover, e-mails related to requirement changes are kept by included parties.

Problem: Bank A and Bank C don't have a formal change process to track and control changes on SRS documents as suggested by IEEE Standard 830.

Expected Situation: IEEE Standard 830 defines prototyping useful for several reasons as follows:

- The customer may be more likely to view the prototype and react to it rather than reading the SRS and react to it. Hence, the prototype provides faster feedback.
- The prototype reveals unanticipated aspects of the systems behavior. It produces not only answers but also new questions.
- An SRS based on a prototype tends to undergo less change during development. So a prototype shortens development time (IEEE, 1998d).

39. Question: Is prototyping used to create more stable requirements during the requirements definition phase?

Current status of Bank A: Prototyping is not used by Bank A in the requirements definition phase. As, current system development methodology of the organization is Waterfall model, it is an expected situation that Bank A does not utilize prototyping.

Current status of Bank B: Prototyping is not used by Bank B in the requirements definition phase.

Current status of Bank C: Prototyping is not used by Bank C in the requirements definition phase. As, current system development methodology of the organization is Waterfall model, it is an expected situation that Bank C does not utilize prototyping.

Problem: No problems have been identified for this question.

Expected Situation: IEEE Standard 830 indicates that software requirements specification documents should have an emphasis on services and functions to be performed rather than specifying design items (IEEE,

1998d). Standard provides a list of issues that software requirements specification document should exclude related to software design such as:

- Partitioning the software into modules;
- Allocating functions to the modules;
- Describing the flow of information or control between modules;
- Choosing data structures.

40. Question: How does the company ensure that SRS documents exclude design requirements?

Current status of Bank A: Bank A's SRS documents include design requirements.

Current status of Bank B: Bank B has three types of documents in the requirements development process that relate to definition of system requirements. Firstly, business requirements document is prepared that is the prelude of requirement development process and this document does not cover any aspects related to design. Afterwards, defined requirements in business requirements document is used to create software requirements document and this document contains design requirements. Finally, software design document is prepared that is the main input to design process.

Current status of Bank C: This issue is controlled in requirements specification review meetings performed with project team.

Problem: Bank A's SRS documents include design requirements which is against the situation suggested by IEEE Standard 830.

Expected Situation: IEEE Standard 830 emphasizes that project requirements which represent an understanding between the customer and the supplier should not be included in the system requirements specification documents (IEEE, 1998d). Standard lists several documents that project requirements should better reside in such as software development plan, quality assurance plan.

41. Question: How does the company ensure that SRS documents exclude project requirements such as cost, delivery schedules?

Current status of Bank A: System requirements specification documents are prepared with respect to draft user guide documents at Bank A which are guidance of specification documents and this document's outline contains no issue related to project requirements. These requirements are included within project management plans at Bank A.

Current status of Bank B: Bank B has three types of documents in the requirements development process that relate to definition of system requirements. Firstly, business requirements document is prepared that is the prelude of requirement development process and this document does not cover any aspects related to project requirements. Afterwards, defined requirements in business requirements document is used to create software requirements document and this document also does not contain project requirements. Finally, software design document is prepared that is the main input to design process. Bank B records and follows project requirements in project management plans according to the process.

Current status of Bank C: This issue is controlled in requirements specification review meetings performed with project team to review requirements specification documents at Bank C.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 830 provides an outline that a good system requirements specification document should include in practice (IEEE, 1998d). Table 5 provided for question 42 in the previous chapter is an outline of a good system requirements specification document given by the standard.

42. Question: How is the SRS document organized?

Current status of Bank A: Bank A's requirements specification documents consist of purpose, business steps, introduction, workflow, program input and output, functions, screen usage, flexible reporting tables sections.

Current status of Bank B: Bank A's requirements specification documents, namely software requirements documents, consist of introduction, scope and objectives, abbreviations, references, general concepts, product perspective, product functions, user profile, limitations, assumptions and interdependencies, requirements sharing, special requirements, external interfaces, functions, success requirements, logical database requirements, design constraints, standards compliance norms, software system attributes, appendices, and traceability matrix sections.

Current status of Bank C: Bank C's scope document that corresponds to requirement specification document consists of definition of requirements, project targets, scope definition, main functions, workflow,

interdependencies, stakeholders, and impact of requirement to current situation, risks and projections, requirements out of scope sections.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 1074 indicates that after conducting the feasibility study system functions should be analyzed to identify total functions of the system. Standard also guides that after analyzing system functions, results should be mapped to functional description of the system (IEEE, 2006a).

43. Question: Are system functions analyzed after the feasibility study? Is functional description of the system drawn from the system functions?

Current status of Bank A: After business unit performs the feasibility study, project management unit provides IT costs to IT committee for project approval. When project is approved by IT committee to start, Bank A prepares a detailed business reasoning that corresponds to requirements specification. This work includes a practice of defining system functions within the process.

Current status of Bank B: After business unit performs the feasibility study and provides business requirements, software requirements definition document is prepared at Bank B which includes product functions and detailed explanation of system functions.

Current status of Bank C: Bank C prepares functional analysis document that is closely correlated with scope documents that correspond to requirements specification documents.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 1074 suggests that after definition of functional description of the system, system architecture should be extracted from the system functions included in functional description of the system (IEEE, 2006a).

44. Question: Is functional description of the system transformed into the system architecture using the methodology, standards, and tools that are established by the organization?

Current status of Bank A: Design report that is prepared at Bank A during design process contains high-level system architecture.

Current status of Bank B: Software design document is prepared using software requirements document at Bank B. Firstly, high level design is performed in this document that also contains software design architecture.

Current status of Bank C: Bank C prepares software architecture, infrastructure, and integration diagrams for large scale system development projects.

Problem: No problem has been identified for this question.

Expected Situation: As a consequence of drawing system architecture from system functions, IEEE Standard 1074 suggests a decomposition of system requirements using system architecture to form software, hardware, interface requirements (IEEE, 2006a).

45. Question: Are the system functions that are documented in the Functional Description of the System divided according to the System Architecture in order to form software requirements, human and hardware

requirements (if applicable), and the System Interface Requirements?

According to what system requirements are grouped by the company?

Current status of Bank A: Bank A generally considers system requirements related to software. Requirements related to hardware are considered in the integrated design meetings at the start of the system development projects. However, Bank A creates system functions in accordance with system architecture.

Current status of Bank B: Bank B decomposes system functions in accordance with system architecture.

Current status of Bank C: Bank C also defines and decomposes system functions with respect to architectural description of a system.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 1074 suggests that user, hardware, software interface requirements should be defined within the requirements documents because standard takes user interface as a critical issue in usability of the system (IEEE, 2006a).

46. Question: Does the software requirements specifications work resulting in SRS document contain user interface requirements?

Current status of Bank A: Bank A's software requirements specification document contains user interface requirements.

Current status of Bank B: Bank A's software requirements document contains user interface requirements.

Current status of Bank C: Functional analysis documents prepared by Bank C to define functional software requirement include user interface requirements.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 1074 guides that after definition and development of system requirements including interface requirements, requirement set should be reviewed by all related parties (IEEE, 2006a). The term related parties here refers to business units who are the actual users of the system.

47. Question: Is software requirements specification document subject to approval of business units to agree on defined system requirements?

Current status of Bank A: Draft user guide which corresponds to SRS document is approved at the end of high level design phase at Bank A.

Current status of Bank B: Business requirements document prepared at the beginning of requirements development process is approved by related business units at Bank B.

Current status of Bank C: Approval of software requirements specification document to agree on defined requirements depends on project type, urgency at Bank C.

Problem: Software requirements specifications are not approved in a routine manner at Bank C as suggested by IEEE Standard 1074.

Expected Situation: IEEE Standard 1061 provides a framework for software quality metrics. Moreover, software quality metrics methodology provided with the framework allows organizations to establish quality requirements for a system at project outset which is given as a key factor to achieve software quality (IEEE, 1998e).

48. Question: Are quality requirements of a system established at the project outset?

Current status of Bank A: Quality requirements of a system are not clearly stated at the project outset at Bank A.

Current status of Bank B: Quality Assurance responsible defines quality control activities at project planning phase at Bank B.

Current status of Bank C: Project targets sections of scope documents include project quality requirements for system development projects at Bank C.

Problem: Quality requirements of a system are not clearly stated at the project outset at Bank A as suggested by IEEE Standard 1061.

Expected Situation: IEEE Standard 730 provides a detailed section outline for software quality assurance plans and suggests this outline as a practice (IEEE, 2002).

49. Question: Is software quality assurance plan produced after the definition of system requirements?

Current status of Bank A: Software quality assurance plan prepared at Bank A includes all issues suggested by IEEE Standard 730 except software reviews, minimum requirements of software quality assurance plan, tests, problem reporting and corrective actions, tools, techniques, methodologies, media control, supplier control, records collection, maintenance and retention, training, risk management, glossary, quality assurance change procedure and history.

Current status of Bank B: Software quality assurance plan prepared at Bank B includes all issues suggested by IEEE Standard 730.

Current status of Bank C: Software quality assurance plan prepared at Bank C includes all issues suggested by IEEE Standard 730 except software reviews, tests, problem reporting and corrective actions, supplier control, records collection maintenance and retention, training, risk management, glossary, quality assurance change procedure and history.

Problem: Software reviews, tests, problem reporting and corrective actions, supplier control, records collection maintenance and retention, training, risk management, glossary, quality assurance change procedure and history sections suggested by IEEE Standard 730 are not created within software quality assurance plans at Bank A and Bank C.

Expected Situation: IEEE Standard 1016 indicates the importance of software design description documents and document contents. In the audience section of the standard indicates that there are general users and creators of software design description documents (IEEE, 1998f). Standard mentions about technical staff as the creator the document.

50. Question: Who prepares the software design description documents?

Current status of Bank A: Design report is prepared by system development responsible and software development responsible at Bank A.

Current status of Bank B: Software design documents are prepared by software development staff at Bank B.

Current status of Bank C: High level design and detailed design documents are prepared by experienced members of software development. Moreover, software development staff collaborates with software architects during design document preparation.

Problem: No problem has been identified for this question.

Expected Situation: Although IEEE Standard 1016 does not indicate that an approval for software design descriptions should exist, it is a known fact that each step of a typical waterfall model is concluded with an approval which indicates satisfactory completion of the phase. Thus, an approval resulting from a peer-review by more experienced designers should exist at this stage.

51. Question: Who approves the design description documents?

Current status of Bank A: Approval of design description documents is not performed at Bank A. However, a general approval mechanism is in place which is given in integrated design meetings that include units except system development and software development.

Current status of Bank B: Approval of design description documents is performed by quality assurance staff and project managers at Bank B.

Current status of Bank C: Technical committee of Bank C approves design descriptions for large scale projects, Moreover, small projects' design descriptions are approved by project managers at Bank C.

Problem: Design description documents are not formally approved at Bank A which is a general guidance of classical Waterfall approach.

Expected Situation: IEEE Standard 1016 provides a design description organization and several design views that can be used to create a design description document (IEEE, 1998f).

52. Question: How is software design documents organized?

Current status of Bank A: Bank A's design documents contain definitions, logical data models, data flow of the system, program

components design, database design, communication analysis, continuity plan, system audit plan sections.

Current status of Bank B: Bank B's software design documents include objective and scope, abbreviations, references, design decisions, high level design, software components, software architectural design, software behavior, data model development, user interface design, traceability to high level requirements, detailed design, software components, software behavior, data model, user interface design, traceability of requirements, and appendices sections.

Current status of Bank C: Bank C's software design documents contain assumptions and interdependencies, standards and limitations, targets and principles, methods, problems, general architecture, process flow, integration, database, infrastructure, non- functional requirements, usability, performance, security, accessibility maintenance, source access information, maintenance sections.

Problem: No problem has been identified for this question. All of the banks use dependency description and detail description views suggested by IEEE Standard 1016.

Expected Situation: IEEE Standard 1074 defines performing architectural design as transforming software requirements and system architecture to high-level design concepts (IEEE, 2006a). In fact, it is identification of software components that constitute the system. All internal interfaces among system components are defined within the software architectural design.

53. Question: Is architectural design (hardware, software and network) performed to transform the software requirements and the system architecture into high-level design concepts? Who performs the architectural design?

Current status of Bank A: Bank A performs architectural design for complex and large scale projects in between analysis and coding stages. Technology architecture management representative joins to meetings as solution architect and provides system architecture for system development projects.

Current status of Bank B: Bank B's design documents include a section named software architecture design and it is a mandatory step in the system design process.

Current status of Bank C: Bank C performs architectural design titled as infrastructure in software design documents.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 1074 and IEEE/EIA Standard 12207.0 both suggest that following the high level design for the system, a detailed design should be prepared for each software component.

IEEE Standard 1074 defines detailed design as choosing design alternatives to implement the functions that are specified for each software component. Standard also annotates that by the end of this activity data structure, algorithm, and control information of each software component are specified (IEEE, 2006a).

54. Question: Are detailed designs prepared indicating data structure, algorithm, and control information of each software component?

Current status of Bank A: Detailed design is performed within design reports prepared at Bank A.

Current status of Bank B: Detailed design is prepared within software design documents generated at Bank B.

Current status of Bank C: Detailed design issues such as data structures algorithms reside within software design documents at Bank C.

Problem: No problem has been identified for this question.

Expected Situation: Although IEEE Standard 1074 and IEEE/EIA Standard 12207.0 don't indicate that there should be an approval for software design descriptions, it is a known fact that each step of a typical waterfall model is concluded with an approval which indicates satisfactory completion of the phase. Thus, an approval resulting from a peer-review by more experienced designers should exist for detailed design and architectural design activities.

55. Question: Are detailed designs and architectural designs approved by related parties? Who is authorized to approve software design descriptions?

Current status of Bank A: Software group managers approve design documents at integrated design meetings of Bank A.

Current status of Bank B: Quality assurance representatives and project managers approve software design documents at Bank B.

Current status of Bank C: Software design documents are approved by technical committee for large scale projects where project managers approve design documents for small projects at Bank C.

Problem: No problem has been identified for this question.

Expected Situation: IEEE/EIA Standard 12207.0 indicates that detailed design should also trigger the user documentation process by implementing preliminary versions and update user documentation as necessary (IEEE& EIA, 1996).

56. Question: Is preliminary versions of user documentation prepared by the design staff?

Current status of Bank A: System development unit gets approval for screens when analyzing the system at Bank A. Moreover, documentation is carried out in parallel to analysis by system development unit.

Current status of Bank B: Draft versions of user documentation are prepared by design staff at Bank B.

Current status of Bank C: Draft versions of user documentation are not prepared by design staff at Bank C.

Problem: Draft versions of user documentation are not prepared by design staff at Bank A and Bank C as suggested by IEEE/EIA Standard 12207.0.

Expected Situation: IEEE/EIA Standard 12207.0 indicates that preliminary versions of test requirements should be prepared during design phase by design staff (IEEE& EIA, 1996).

57. Question: Is preliminary versions of test requirements prepared by the design staff?

Current status of Bank A: Preparation of preliminary test requirements is carried out by system development unit at Bank A.

Current status of Bank B: Preliminary versions of test requirements are prepared by software design staff at Bank B.

Current status of Bank C: Preliminary versions of test requirements are prepared by software design staff at Bank C. However, this issue is taken into consideration with current CMMI process improvement efforts of the company.

Problem: Preliminary versions of test requirements are not prepared by design staff at Bank A and Bank C as suggested by IEEE/EIA Standard 12207.0.

Expected Situation: IEEE/EIA 12207.0 standard's development process indicates that developer should develop plans for conducting the activities of the development process. Furthermore, standard guides that these plans should be documented and executed (IEEE& EIA, 1996).

58. Question: Are development plans created for the development phase of the projects by development department personnel?

Current status of Bank A: When project is sent to IT committee for approval, software development unit provides effort estimation for the project. After the approval and during starting phase of the project, work breakdown structure is prepared for software development plans.

Current status of Bank B: Development plans and schedules are prepared by project managers at Bank B and project members such as development staff work in accordance with these plans.

Current status of Bank C: Bank C prepares a work schedule as software development plan for system development projects.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 1074 indicates that source code should be generated including suitable comments (IEEE, 2006a).

59. Question: Are there any coding/commenting standards or procedures that development team has to apply during development? What are the standards in place?

Current status of Bank A: Bank A does not have coding, commenting standards and procedures for software development.

Current status of Bank B: Applications developed for main systems are controlled with custom coding standards prepared by Bank B. Moreover, Bank B tries to comply with internationally accepted standards for the applications developed on open systems such as Java, .Net.

Current status of Bank C: Bank C creates a manual log for all the line changes performed on source code which includes version, release number, day, month, year, project code, change number, and detailed change description.

Problem: Coding and commenting standards and procedures are not in place at Bank A and Bank C as suggested by IEEE Standard 1074.

Expected Situation: IEEE Standard 1074 emphasizes that prior to the distribution of the software code reviews should be conducted (IEEE, 2006a). Reviews mentioned here are peer reviews to be performed by experience development professionals of software quality assurance specialists to verify compliance to corporate standards.

60. Question: Is there a review process for the coding to verify compliance to the corporate standards? What are the methods being used for the review process?

Current status of Bank A: Code review is defined as a software quality assurance activity at quality assurance plans of Bank A. Either

quality assurance responsible or a peer from a different development group reviews the work of a colleague with respect to this quality assurance activities.

Current status of Bank B: Code review is performed in two ways at Bank B. Firstly; static code review is performed by special tools. Secondly, quality assurance group performs manual reviews on source code.

Current status of Bank C: Peer-to-peer review is performed at Bank C where software engineers at the same level review each others code in the process. Moreover, Bank C has established required checklists and procedures for the reviews to be performed by review group. But, company has not started using these procedures and checklists.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 1074 guides that following the creation of source code operation documentation should be created by related personnel. Standard also states that operation documentation is required to install, operate, and support the system throughout the life cycle (IEEE, 2006a).

61. Question: Are operating documents prepared for the developed system for installing, operating, and supporting the system throughout the life cycle?

Current status of Bank A: Although this process is not performed for each project, if attendance of operation unit is required for the project, operational system documents are prepared at Bank A. This issue is under control of project managers at Bank A.

Current status of Bank B: Detailed operating documents are not prepared at Bank B.

Current status of Bank C: Operating documents to install, to operate, and to support the system are prepared at Bank C.

Problem: Bank B does not prepare operating documents to install, to operate, and to support the system as guided by IEEE Standard 1074.

Expected Situation: IEEE Standard 1074 puts emphasis on packaged software concept and states that software installation consists of transporting and installing the software from the development environment to the target environments. Moreover, standard indicates that software should be packaged before distributing to target environments (IEEE, 2006a).

62. Question: How is the software to be delivered to test& integration environments packaged? Is it able to modify software after packaging?

Current status of Bank A: Bank A uses a versioning and packaging tool for packaging software to be delivered to target environments. Bank A generally packages latest changes for the test environment. As integration environment is established to test production packages and final deployment, Bank A creates packages similar to production environment for integration environment. When source code is packaged once, it is not accurate to change the package at Bank A's practices. Instead, repackaging the source code following the change is performed to prevent problems.

Current status of Bank B: After software development has matured to some extent, software is base lined by software development staff at Bank B. Software is tagged with initial label and it is recommended to migrate to

test environments. Base lined software is packaged by configuration group and transferred to test environments. Base lining and packaging is repeated when changes are implemented for the software.

Current status of Bank C: Software packaging is performed with respect to Service Management System records at Bank C by operation and software distribution units which means software is packaged only if there is a request by software development staff. If a change is required for the packaged software, new requests are generated on Service Management System and repackaging is performed by operation and software distribution units instead of changing existing packages.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 828 provides minimum requirements of a software configuration management plan (IEEE, 2005). Standard gives a definition of SCM document stating that this document is intended to specify:

- What SCM activities are to be done?
- How they are to be done?
- Who is responsible for doing specific activities?
- When they are to happen?
- What resources are required?

63. Question: Does the company produce a software configuration management (SCM) plan for the whole system development process?

Current status of Bank A: It has been stated that Bank A is redefining software configuration management process in the scope of CMMI process improvement efforts.

Current status of Bank B: Bank B has created two types of documents for the configuration management process. One of them is configuration management rules document which defines general principles of configuration management. In addition to that, configuration management plan document is prepared for each project. These two documents cover all aspects of software configuration management suggested by IEEE Standard 828.

Current status of Bank C: It has been stated that after the completion of current CMMI process improvement efforts, software configuration management plan will be prepared and all activities required by the standard will be created for the projects. Moreover, Bank C will establish a relation between software configuration management plan and project management plan in terms of scheduling configuration management activities.

Problem: Software configuration management plans are not created by Bank A and Bank C as suggested by IEEE Standard 828.

Expected Situation: IEEE Standard 828 emphasizes that all of the external constraints on the SCM plan should be identified when these constraints relate to a procedure or a policy related to software configuration management (IEEE, 2005).

64. Question: Has the company documented a software configuration management procedure? What type of configuration management policy does the company use in practice?

Current status of Bank A: Bank A is at the preparation stage for software configuration management procedure and configuration management policy.

Current status of Bank B: Bank B has established software configuration management rules as a procedure that guides responsible personnel for software configuration management activities. Company's approach to SCM is given in detail at SCM rules document. However, software configuration management policy is not created by Bank B.

Current status of Bank C: Bank C uses Information Technology Infrastructure Library (ITIL) based configuration software configuration management process. According to this process, a policy exists where unlicensed software can not be used, changes on configuration items are recorded at configuration management database, and software versioning is performed. However, Bank C does not have a formal software configuration management procedure that is used to carry out SCM activities.

Problem: Software configuration management policy is not created by Bank A and Bank B as suggested by IEEE Standard 828.

Problem: Software configuration management procedure is not created by Bank A and Bank C as suggested by IEEE Standard 828.

Expected Situation: IEEE Standard 828 states that tasks of software configuration management should be allocated to related units and this allocation and responsibilities should be documented in the process (IEEE, 2005).

65. Question: Are roles and responsibilities documented for the SCM process?

Current status of Bank A: B It has been stated that Bank A is redefining software configuration management process in the scope of

CMMI process improvement efforts. Hence, roles and responsibilities for technical and managerial activities are being prepared by Bank A.

Current status of Bank B: Roles and responsibilities are documented in the software configuration management process for both technical and managerial configuration management activities at Bank B.

Current status of Bank C: Roles and responsibilities are not documented in the software configuration management process for technical and managerial configuration management activities at Bank C.

Problem: Roles and responsibilities for technical and managerial activities of SCM process are not documented at Bank A and Bank C.

Expected Situation: IEEE Standard 1074 guides on what release management planning should include such as release management organizations and responsibilities, procedures, tools, techniques, and methodologies, release frequency, release milestones, release media, build procedures and naming conventions, branching models, packaging requirements, and delivery media (IEEE, 2006a).

66. Question: Does the company create a release management plan that contains overall software release management objectives, including release frequency, release milestones, and release media?

Current status of Bank A: Although there is not a specific release planning at Bank A, releases to be deployed to bank's branches are produced twice a month and these releases are planned by branch operations group. All related deployment parties comply with plans prepared by branch operations group. On the other hand, bank's branch release transition is performed on Saturday or Sunday as a principle at Bank A.

Current status of Bank B: Bank B does not have a detailed release management plan. However, release dates are defined and published beforehand at Bank B. Bank's release method, tools, and some releasing principles are included in configuration management rules document created by the company.

Current status of Bank C: Although Bank C does not have a general and detailed release management plan; there are defined procedures for several technological platforms which are applied for release management. In addition to that, delta release structure is used and release days and approval mechanisms are documented at Bank C. Delta release is one that includes only those configuration items within the release unit that have actually changed or are new since the last full release.

Problem: An overall, detailed release management plan including software release management objectives, including release frequency, release milestones, release media, build procedures and naming conventions, branching models, and delivery media is not prepared by Bank A, Bank B, Bank C as suggested by IEEE Standard 1074.

Expected Situation: Although IEEE Standard 828 does not indicate necessity of a configuration management system, terms mentioned in the standard such as version naming standards, naming configuration items, acquiring configuration items, configuration items access are generally governed by configuration management systems.

67. Question: Is there a versioning system used for the configuration items? Are the configuration items governed by a system?

Current status of Bank A: Bank A uses a configuration system in order to manage versioning issues and changes on configuration items.

Current status of Bank B: Bank B also uses version control tools such as IBM Rational Clear Case and IBM SCLM.

Current status of Bank C: Although Bank C is using several tools for versioning; there is an ongoing improvement effort to reach to a compliance with best practices and methodologies. In-house developed Service Management System is used to manage changes on configuration items where ITIL based change management processes are used by Bank C.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 828 has a specific section for naming configuration items. Standard indicates that software configuration management plan should also include standard methods for naming and labeling configuration items (IEEE, 2005).

68. Question: Are there any standards in place related to version naming, marking, documentation labeling for the releases?

Current status of Bank A: Bank A has created version naming, marking and labeling standards for main branch release which is the last release before migration to production.

Current status of Bank B: Bank B has prepared and documented versioning standards.

Current status of Bank C: Each technological platform has its own versioning standards at Bank C. Moreover, there is an ongoing project to consolidate these different standards and create a common versioning standard.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 828 suggests that access control procedures should be referenced in the software configuration management plan for each configuration item and configuration library (IEEE, 2005).

69. Question: Are there any procedures related to access to the software libraries and retrieval of configuration items from software libraries? What are the access rights for several user groups? Is everyone able to access and retrieve configuration items?

Current status of Bank A: Access to configuration items is defined according to the roles and responsibilities at Bank A. Each group that performs development on configuration items or responsible of operating configuration item has update rights where the rest have read only rights on the configuration item. Finally, configuration items such as quality documents are reachable by everyone.

Current status of Bank B: All users have access to software assets for main systems but they only have update rights for some libraries according to their responsibilities. However, users can view only the libraries where they are given access rights and have update permission for open systems. Users can perform changes at development level at both systems where changes in production level are performed only by configuration management group.

Current status of Bank C: Each technological platform uses its own configuration library at Bank C and software development team leaders assign necessary access rights to team members.

Problem: Access to the software libraries and retrieval of configuration items from software libraries are not governed by formal procedures at Bank A, Bank B, and Bank C.

Expected Situation: IEEE Standard 828 suggests that software configuration management plan should address change controls imposed on the base lined configuration items such as identification of change, analysis and evaluation of a change request, approval or disapproval of a change request, verification, implementation, and release of a change (IEEE, 2005).

70. Question: How is the change process on baseline configuration items managed? How is change identified and documented? How the change request is recorded, analyzed and evaluated? How is the change request approved or disapproved? How is the change implemented and released?

Current status of Bank A: Bank A has an organizational unit named change management to handle changes on configuration items. Change management unit operates with respect to its operational procedures. Whenever there is a need for a change on configuration items, a request is generated on SAP system and manager of the requestor approves the request. If the request has an urgency, problem record is asked from the business unit to further implement the request.

Current status of Bank B: Bank B has a documented change management process and change requests are recorded at change management tools of the organization which are Clear Quest and T.Test.

Current status of Bank C: Bank C uses an ITIL based change management process and changes are documented with respect to their

sizes. Moreover, Bank C either creates a project for changes or changes are associated with existing projects using Service Management System. Changes are taken into consideration as delta releases and monitored using records created in an in-house developed system in terms of project and resources. Finally, change requests are approved by predefined users at in-house developed system.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 828 emphasizes that both change requests and records to track sequence of change process should be kept and identified by the software configuration management plan (IEEE, 2005).

71. Question: Is there a change log kept by the SCM system regarding the details of changes on configuration items? For how long are the logs kept? Are the logs removed completely after some time?

Current status of Bank A: Changes on configuration items are stored at configuration management database at Bank A. Records older than four years in this database are backed up and removed.

Current status of Bank B: Changes on configuration items are stored without a time constraint at Bank B. Bank B currently possesses change records since 1993 in its change management tools.

Current status of Bank C: Change logs are kept with different time constraints for different technological platforms at Bank C. When log duration of a platform is reached, change logs of configuration items are backed up in accordance with company's backup policies.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 828 guides that if there is a vendor or subcontractor within the system development project, there should be a monitoring process within the software configuration management plan to ensure compliance to the organization's system development standards (IEEE, 2005).

72. Question: If the coding stage of the system development process is outsourced what kind of monitoring process is in place for the contractors?

Current status of Bank A: Subcontractors fill out timesheets to indicate worked hours at Bank A. Project managers and functional unit manager is responsible of tracking and approving subcontractor timesheets. Because, Bank B makes payment to subcontractors using timesheet records. However, a software project's coding stage is not totally outsourced at Bank A and norm staff concept is implemented for software development process where some part of a software development process is outsourced.

Current status of Bank B: Bank B applies its procurement process to subcontractors and this process contains items for subcontractor monitoring. According to this step, project manager monitors subcontractors with respect to contracts using several methods such as asking project progress reports, arranging progress evaluation meetings. As a result of monitoring, project manager performs an evaluation in the dimensions of compliance to schedule and cost plans, compliance to bank's processes, deliverables' compliance to specifications. Finally, issue management process is applied for discrepancies at the end of evaluation.

Current status of Bank C: Bank C reviews results of coding performed by subcontractors according to predefined dates at the beginning of the project. Development effort performed by subcontractors is also shared and reviewed at these dates.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 828 indicates that some issues of subcontracting should be planned beforehand in the software configuration management plan, including reviews to be performed on subcontractor's configuration items (IEEE, 2005).

73. Question: How the work of the contractor is reviewed for compliance with the development standards of the enterprise?

Current status of Bank A: Bank A performs code review process to subcontractors which is also applied to in-house developed software.

Current status of Bank B: Bank B performs technical review on subcontractor's software and executes functional software tests to accept outsourced software.

Current status of Bank C: Bank C has technology platform based code review products and these products are used to verify subcontractor's software. Moreover, experienced software engineers perform sampling and review to ensure compliance to corporate standards.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 828 suggests that planning of testing, verification, and acceptance should be performed beforehand for subcontracted software. In fact, standard guides that planning information of

these activities should be embedded to Software Configuration Management Plan (IEEE, 2005).

74. Question: How external code, documentation, and data of the contractor is tested, verified, accepted, and merged with the project software? Is there a review process for the outsourced coding?

Current status of Bank A: Bank A does not separate subcontractor's software and in-house developed software in terms of software acceptance. User acceptance tests and tests applied by system development are applied on subcontractor's software and it is planned within software project management plans.

Current status of Bank B: Software acceptance conditions for subcontractors are defined within the contracts signed with subcontractors. Bank B generally performs reviews and test with respect to quality assurance, test, and integration processes of organization.

Current status of Bank C: Subcontractor's software is scanned with code security and code review products at Bank C. Afterwards; software is tested using test scenarios that are drawn from software requirements. After integrating the software components and system components, integration test and system tests are performed and software is accepted according to the results of integration and system tests.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 1062 guides to establish a software acquisition process that fits the organization's needs (IEEE, 1998b).

75. Question: Does the company have a defined software acquisition process for outsourcing the software?

Current status of Bank A: Bank A does not have a defined software acquisition process. However, supplier selection and procurement procedures are created and being executed at Bank A.

Current status of Bank B: Bank B has defined its procurement management process which includes software acquisition process in detail.

Current status of Bank C: Bank B does not have a standard software acquisition process. However, this issue is taken into consideration with current CMMI process improvement efforts and company is defining standard processes.

Problem: Bank A and Bank C have not created a standard software acquisition process as suggested by IEEE Standard 1062.

Expected Situation: IEEE Standard 1062 has established five milestones for software acquisition first of which is called Planning Phase. Planning phase includes release of Request for Proposal (RFP) document and this phase is stated to begin when RFP is created by the organization (IEEE, 1998b).

76. Question: Does the company produce Request for Proposal (RFP) document which contains requirements for the software to be purchased and product quality and maintenance plans? Who is responsible of preparing the RFP document?

Current status of Bank A: Bank A generates Request for Proposal (RFP) and Request for Information (RFI) documents to forward to suppliers. These documents are prepared by purchasing department or predefined

people at the project team such as system development responsible or project management responsible.

Current status of Bank B: Bank B also produces RFP documents for suppliers and these documents are prepared by project managers.

Current status of Bank C: Bank C prepares RFP documents whenever required by the company. Business unit or Information Technology unit that requires the product or service prepares RFP document.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 1062 suggests that companies should have set supplier evaluation criteria. This standard also provides methods to identify suppliers (IEEE, 1998b).

77. Question: How are the potential suppliers identified and evaluated? Please explain company's supplier evaluation and selection criteria?

Current status of Bank A: Information Technology unit is responsible of defining companies to work with as a supplier considering criteria such as technical sufficiency, previous experiences, and references of the company. On the other hand, price evaluation is performed by purchasing department. It has been stated that weights of evaluation and selection criteria might vary from project to project.

Current status of Bank B: It has been stated that evaluation and selection criteria can change on a procurement basis at Bank B. However, general criteria taken into consideration are functional appropriateness,

technical appropriateness, security, customer references, financial structure, cost, market coverage of the supplier.

Current status of Bank C: Potential suppliers are defined via the exploration performed by the organizational unit that owns the requirement at Bank C. Evaluation and selection criteria are market coverage, references, accessibility, cost and quality of the supplier. Bank C also manages proof of concept projects if required, and results of the project are used as evaluation criteria.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 1062 suggests that company should have developed a set of supplier evaluation criteria to use in reviewing supplier proposals (IEEE, 1998b).

78. Question: How is supplier proposals evaluated?

Current status of Bank A: Supplier proposal are evaluated by purchasing and IT departments using supplier evaluation criteria of the company such as technical sufficiency, previous experiences, and references of the supplier.

Current status of Bank B: Project team performs the initial evaluation for supplier proposals using criteria such as functional appropriateness, technical appropriateness, security, customer references, financial structure, cost, market coverage; prepares a report and presents the report to the upper management for decision at Bank B.

Current status of Bank C: Bank C uses set of supplier evaluation criteria such as market coverage, references, accessibility, cost and quality

of the supplier. Bank C prepares an evaluation report using these criteria and unit managers or upper level management makes the final decision.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 1062 suggests that quality of work to be done should be clearly stated in the contract in terms of acceptance criteria. These criteria are later used in detail when accepting the software (IEEE, 1998b).

79. Question: Are acceptance criteria defined at the contracts for selected suppliers?

Current status of Bank A: Bank A documents acceptance criteria at the contracts signed with the suppliers.

Current status of Bank B: Bank B documents acceptance criteria at the contracts signed with the suppliers.

Current status of Bank C: Bank C documents acceptance criteria at the contracts signed with the suppliers for each engagement.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 1062 suggests defining a statement of work indicating responsibilities of supplier and the company for each task during the project (IEEE, 1998b).

80. Question: Are supplier and acquirer obligations stated and agreed at the contract?

Current status of Bank A: Bank A clearly documents obligations of bank and the supplier within the contracts signed with the supplier.

Current status of Bank B: Bank A clearly documents obligations of bank and the supplier within the contracts signed with the supplier.

Current status of Bank C: Bank C documents obligations of bank and the supplier as clear as possible within the contracts. Moreover, legal department of the company assists departments in contracting issues.

Problem: No problem has been identified for this question.

Expected Situation: IEEE/EIA Standard 12207.0 suggests that each software unit and database developed by the developer should be documented (IEEE& EIA, 1996).

81. Question: Is each software unit or database developed documented by the related development staff? Who is in charge of coding documentation?

Current status of Bank A: Bank A is in the process structuring stage for recording software development.

Current status of Bank B: Bank B does not document each software unit during software development process. But, documentation of development is partially performed for some applications. Application development is responsible of development documentation at Bank B.

Current status of Bank C: Although Bank C does not document each software unit during software development process; it strives to perform documentation for each development. Software developer is responsible of development documentation at Bank C.

Problem: Each software unit or database development effort is not documented at Bank A, Bank B, and Bank C.

Expected Situation: IEEE/EIA Standard 12207.0 suggests that following the coding phase of the software, test data and test procedure for

testing each software unit should be developed and documented by the developers (IEEE& EIA, 1996).

82. Question: Are test procedures and test data created? Who develops test plans and test data?

Current status of Bank A: Bank A does not perform preparation of test procedures. However, test data is prepared by software development unit and system development unit at test environment.

Current status of Bank B: Project managers decide upon testing methods, test levels at Bank B. Moreover, project members that are responsible of testing prepare test plan and test data at Bank C.

Current status of Bank C: Test procedures and test data are created by test group at Bank C.

Problem: No problem has been identified for this question.

Expected Situation: IEEE/EIA Standard 12207.0 suggests that developer should test each software component and document the results (IEEE& EIA, 1996).

83. Question: Is developed software subject to unit testing? Who performs the unit testing? Are the test results documented?

Current status of Bank A: Bank A performs unit testing at development environment and unit test record form is filled out by executers of the unit tests.

Current status of Bank B: Information systems project members perform unit tests at Bank B. However, results of unit tests are not formally documented at Bank B.

Current status of Bank C: Each software engineer has to perform unit testing after implementation at Bank C. However, results of unit tests are not formally documented at Bank C. It has been stated that this issue will be taken into consideration with current CMMI process improvement project and engineers will be forced to fill out unit test checklists.

Problem: Results of unit tests are not formally documented at Bank B and Bank C.

Expected Situation: IEEE/EIA Standard 12207.0 and IEEE/EIA Standard 12207.2 both denote that in the development process of software life cycle processes the developer should develop an integration plan to integrate the software units and document the plan (IEEE& EIA, 1996).

84. Question: Is integration testing plan created/documented? Who plans and documents integration tests?

Current status of Bank A: Integration test planning is mandatory in the project plans at Bank A and it is performed by system development unit.

Current status of Bank B: Bank B prepares test and integration plan documents together in the system development process. However, this document is not prepared for all of the system development projects at Bank B. Test responsible in the project team prepare test and integration plan.

Current status of Bank C: Bank C currently does not prepare integration test plans for system development projects. However, this issue is taken into consideration with current CMMI process improvement project and test team leaders will be responsible of preparing integration test plans.

Problem: Integration test plans are not prepared for all projects at Bank B and Bank C as suggested by IEEE/EIA Standard 12207.0 and IEEE/EIA Standard 12207.2.

Expected Situation: IEEE/EIA Standard 12207.0 denotes that early versions of user documentation should be prepared following the software architectural design. Moreover, standard states that software user documentation should be updated as necessary in the development process (IEEE& EIA, 1996).

85. Question: Is draft user documentation started at the development phase? If no at which phase does the user documentation start?

Current status of Bank A: Draft user guide is prepared within analysis phase at Bank A.

Current status of Bank B: User documentation is prepared by application test group in the system testing phase at Bank B.

Current status of Bank C: User documentation is prepared in the testing phase at Bank C.

Problem: Draft versions of user documentation are not prepared in the development process at Bank B and Bank C as suggested by IEEE/EIA Standard 12207.0.

Expected Situation: Standard: IEEE Standard 1074 suggests that test procedures for different levels of tests should be prepared as an input to preparation of test data and execution of the tests including unit, module, component, integration, acceptance, regression, and system tests. Moreover, standard indicates that test procedures should define types of tests to be

conducted such as white box, black box, destructive, noninvasive tests (IEEE, 2006a).

86. Question: Has the company established test procedures for the following?

Current status of Bank A: Bank A executes pre-production test, pilot test at bank branches, unit tests, integration test, and acceptance test. Moreover, test procedures for unit tests, integration tests, and acceptance tests have been prepared by Bank A.

Current status of Bank B: Test methods to be applied during tests, and test levels are stated at Test and Integration Plan prepared at Bank B. Bank B does not use separate procedures for test methods. In addition to that, steps to be implemented during test execution are explained with test scenarios.

Current status of Bank C: Bank C has documented test procedures for each level of testing performed such as unit testing, acceptance testing, and integration testing.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 1074 suggests that combining software components into a system should be planned beforehand (IEEE, 2006a).

87. Question: Are integration plans created for system development projects to combine software components into an overall system?

Current status of Bank A: Bank A has a step for planning of integration within project management plans and it is expected to create

integration plans for system development projects. However, integration plans are not created at each project at Bank A.

Current status of Bank B: Bank B creates steps of integration within Test and Integration plan document. But, this document is not prepared for all of the system development projects.

Current status of Bank C: Bank C prepares integration plans for all system development projects and this issue will be monitored with a traceability matrix using CMMI in the future.

Problem: Integration plans are not prepared for all system development projects at Bank A and Bank B as suggested by IEEE Standard 1074.

Expected Situation: IEEE/EIA Standard 12207.0 and IEEE/EIA Standard 12207.2 state that after integrating software components with hardware items and other systems, aggregates should be tested and integration test results should be documented (IEEE& EIA, 1996).

88. Question: Is integration testing performed? Are the results of integration testing documented?

Current status of Bank A: Integration tests are performed at every system development project at Bank A and results of the tests are documented and stored within project folders.

Current status of Bank B: Bank B also performs integration tests at every system development project. However, results of integration tests are documented by application test group for some projects.

Current status of Bank C: Bank C performs integration tests for system development projects and results of integration test are recorded in test defect logs.

Problem: Results of integration tests are not documented for all system development projects at Bank B as suggested by IEEE/EIA Standard 12207.0 and IEEE/EIA Standard 12207.2.

Expected Situation: IEEE Standard 1074 defines post-development activities first of which is Installation Activities. In addition to that, a detailed explanation of installation is given within the standard stating that installation consists of the transportation and installation of software from the development environment to the target environment (IEEE, 2006a).

89. Question: Which organizational unit is responsible of checking out the software from the development environment and transferring to target environments?

Current status of Bank A: Change management unit is responsible of transferring the software from development environment to target environments at Bank A.

Current status of Bank B: Technical test group checks out the software from the development environment, compiles and packages the software at Bank B. Moreover, distribution of package to target servers is performed by system operation group at Bank B.

Current status of Bank C: Software development unit transfers software from development to test environment at Bank C. In addition to that, transfer of software to production environment is performed by operation unit at Bank C.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 1074 defines post-development activities first of which is Installation Activities. In addition to that, a detailed explanation of software installation is given within the standard stating that packaged software, and any required database data, should be installed in the target environment according to the procedures of the organization (IEEE, 2006a).

90. Question: Which organizational unit is responsible of installing the test environment?

Current status of Bank A: System development staff is responsible of installing test environment at Bank A. Hardware, database, operating system installation is performed by technical support unit at Bank A.

Current status of Bank B: Environments such as integration test and upper level test environments are managed by data processing management unit at Bank B.

Current status of Bank C: Application management unit is responsible of installation of client environments at Bank C, where system management unit is responsible of installing server environments.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 1074 suggests that test procedures should cover test environment components and data to be used in testing (IEEE, 2006a). In fact, existence of test environments is to simulate production environment and detect errors earlier in the process.

91. Question: How does the organization ensure that test environment reflects production environment as much as possible (data,

tools)? Which method is used to keep test environment similar to production environment as much as possible?

Current status of Bank A: It has been stated that Bank A is working on building user acceptance testing environment and this environment will not be accessible by most of the personnel to prevent synchronization problems with production environment. But, as information technology staff and test staff is authorized to access current test environment at Bank A, it has been stated that bank is having some problems in terms of synchronization because of frequent changes in the environment.

Current status of Bank B: Bank B performs continuous data synchronization between test and production environment. Moreover, when the project is in testing phase, project members prepare updated test data. Maintenance of the tools at the test environment is continuously performed by data processing management staff. As a result, Bank B ensures that software release difference between test and production environment is at most one release.

Current status of Bank C: Bank C continuously exchanges data between test and production environment by using a special tool. Moreover, Bank C currently explores tools to generate test data.

Problem: Bank A does not have a formal method to keep test environment as much as similar to production environment as suggested by IEEE Standard 1074.

Expected Situation: IEEE Standard 1074 suggests that installation to the target environments should be documented with the problems encountered during installation (IEEE, 2006a).

92. Question: Is operation log of the installation kept to keep track of encountered problems during installation?

Current status of Bank A: Bank A does not keep operational problem records of installation to test environment.

Current status of Bank B: Bank B keeps operational problem records of installations performed at test environment.

Current status of Bank C: Reasons of problems encountered during installing test environment are defined and communicated to production deployment unit at Bank C. However, Bank C aims to keep record of problems encountered after completion of current CMMI process enhancements.

Problem: Problems encountered during installation to test environment are not documented at Bank A and Bank C.

Expected Situation: IEEE Standard 829 defines the purpose of the test plans to be used in the testing process with several dimensions and mentions several aspects that a test plan should include such as scope, approach, resources, and schedule of the testing activities. Moreover, standard also indicates that test plan should include issues like items being tested, the features to be tested, the testing tasks to be performed, and the personnel responsible for each task (IEEE, 1998g).

93. Question: Are acceptance test plans produced with respect to the analysis documents? Who prepares the acceptance test plan document?

Current status of Bank A: Bank A prepares user acceptance test plans with respect to analysis documents. User acceptance testing unit within the operations team prepares user acceptance test plans. Moreover,

Bank A documents scope, resources, schedule for testing activities, items to be tested, features to be tested, testing tasks to be performed, personnel responsible for each task within acceptance test plans. However, approach and risks associated with the plan are not documented within acceptance test plans at Bank A.

Current status of Bank B: Instead of preparing a separate acceptance test plan, Bank B prepares acceptance test plan steps within test and integration plan. Test and integration plan template contains items such as scope, approach, resources, schedule for testing activities, items to be tested, features to be tested, testing tasks to be performed, personnel responsible for each task, and risks associated with the plan. But, it has been stated that test and integration plans are not prepared using all these details at every system development project.

Current status of Bank C: Bank C prepares acceptance test plans covering items such as scope, approach, resources, schedule for testing activities, items to be tested, features to be tested, testing tasks to be performed, personnel responsible for each task, and risks associated with the plan. These plans are documented by test team leaders at Bank C.

Problem: Bank B does not prepare acceptance test plans including all the aspects suggested by IEEE Standard 829 for each system development project.

Expected Situation: In the test plan section of IEEE Standard 829 it is suggested to place an approvals section where names and titles of the persons to approve the test plan are documented (IEEE, 1998g).

94. Question: Who approves acceptance test plans?

Current status of Bank A: Acceptance test plans are approved by user acceptance testing unit manager and project manager at Bank A.

Current status of Bank B: Test and integration plan is approved by test leader, project manager, and quality assurance responsible within project team at Bank B.

Current status of Bank C: Acceptance test plans are approved by project managers at Bank C.

Problem: No problem has been identified for this question.

Expected Situation: IEEE Standard 829 states that test design specification document is used to refine test approach and identify the features to be covered by the design and its associated tests. It also identifies the test cases and test procedures, required to execute testing and specifies the feature pass/fail criteria for test cases (IEEE, 1998g). Furthermore, this standard provides an outline for test design specification content including test design specification identifier, features to be tested, approach, test identification, pass/ fail criteria.

95. Question: Are test design specification documents prepared?
Who prepares the documents?

Current status of Bank A: Bank A does not prepare test design specification documents to specify the test approach and methods to be used and pass/fail criteria for the software features.

Current status of Bank B: Test and integration test plan template used at Bank B contains all the steps that a test design specification document should include along the process. But, it has been stated that test

and integration plans are not prepared using all details related to test design specification at every system development project.

Current status of Bank C: Bank C does not prepare test design specification documents to specify the test approach and methods to be used and pass/fail criteria for the software features.

Problem: Test design specification documents are not prepared to specify the test approach and methods to be used and pass/fail criteria for the software features by Bank A, Bank B, and Bank C.

Expected Situation: According to IEEE Standard 829, one of the crucial elements of test specification is test case specification which should be in harmony with the test design specification. Standard provides purpose of test case specification as to define a test case identified by a test design specification. Furthermore, this standard gives a structure that a test case specification document should have including test case identifier, test items, input specifications, output specifications, environmental needs, special procedural requirements, and intercase dependencies (IEEE, 1998g).

96. Question: Are test case specification documents prepared? Are test specifications and constraints defined per test cases?

Current status of Bank A: Bank A prepares test case specification documents to define scenario specifications and test constraints. Test case specification documents prepared at Bank A includes test items, input specifications, output specifications, and intercase dependencies between test cases. However, test case specification identifier, environmental needs, and special procedural requirements are not included within test case specification documents at Bank A.

Current status of Bank B: Test and integration plan template contains items such as test case specification identifier test items, input specifications, output specifications, environmental needs, special procedural requirements, and intercase dependencies for test case specification documentation at Bank B. But, it has been stated that test case specification documents are not documented using all these detail at every system development project.

Current status of Bank C: Bank C prepares test case and scenarios documents including items such as test case specification identifier test items, input specifications, output specifications, environmental needs, special procedural requirements, and intercase dependencies.

Problem: Bank B does not prepare test case specification documents at each system development project as suggested by IEEE Standard 829.

Problem: Test case specification identifier, environmental needs, and special procedural requirements are not included within test case specification documents at Bank A as suggested by IEEE Standard 829.

Expected Situation: : IEEE Standard 829 defines four report types that should be produced during test execution two of which are test log and test incident report. Test log is defined as record of what occurred during test execution and test incident report is defined as any event that occurs during the test execution which requires further investigation (IEEE, 1998g).

97. Question: Is test log prepared by the test team during test execution? What actions are taken for the incidents?

Current status of Bank A: Whenever a problem is encountered during test execution, problem notification form is prepared by test staff at Bank A. Afterwards, form is examined by IT and problems are classified according to their types. Moreover, problems are followed by IT staff until all of them are resolved and reach closed status.

Current status of Bank B: Whenever a problem is encountered during test execution, a defect record is created via test management tool at Bank B. Moreover, Bank B keeps records of test results.

Current status of Bank C: Whenever a problem is encountered during test execution, a defect log document is prepared and shared with software development group at Bank C. If there are a lot of errors that blocks testing process, situation is evaluated again with software development unit.

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 829 places an approval section for test summary report which indicates that test summary reports should be approved to ascertain test results are compliant with company's standards and tests are executed with respect to defined test cases and test designs (IEEE, 1998g).

98. Question: Are test summary reports approved? Who approves?

Current status of Bank A: Test summary reports are prepared only for unit tests and results of unit tests are not approved at Bank A.

Current status of Bank B: Test summary reports are approved by test managers at Bank B.

Current status of Bank C: Test summary reports are not approved at Bank C. However, this issue is taken into consideration with current CMMI process improvements and test summary reports will be approved by project managers.

Problem: Results of tests performed are not approved by authorized personnel at Bank A and Bank C as suggested by IEEE Standard 829.

Expected situation: IEEE Standard 1062 defines nine phases for software acquisition where number eight in the process is accepting the software. Standard defines that there should be an established process to certify correction of discrepancies and satisfaction of acceptance criteria (IEEE, 1998b).

99. Question: What type of software acceptance process is applied to the suppliers (package software purchase)?

Current status of Bank A: Bank A executes the same software acceptance process applied to in-house developed software to suppliers for packages software purchases.

Current status of Bank B: Bank B uses its procurement management process to accept subcontractor's software.

Current status of Bank C: Bank C does not have a defined process to accept subcontractor's software because subcontracting is not generally preferred by Bank C. However, if Bank C needs to accept subcontractor's software, acceptance criteria defined within the contracts are tested and discrepancies are fixed with the subcontractor.

Problem: Bank C does not have a defined software acceptance process for subcontractors as suggested by IEEE Standard 1062.

Expected situation: IEEE Standard 1074 contains an activity named Accept Software in Operational Environment. This activity suggests that a user acceptance should be performed to verify that developed software satisfy defined customer requirements (IEEE, 2006a).

100. Question: How does the customer accepts the developed software? What is the practice of the company?

Current status of Bank A: Special test staff exists at business end to accept developed software at Bank A and user acceptance tests are performed by test staff using test cases provided by IT department of the bank.

Current status of Bank B: Bank B performs acceptance testing process if required by the internal customers.

Current status of Bank C: User acceptance testing is performed by internal customers to accept developed software at Bank C.

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 1074 indicates that related project information should be collected and placed in the project records. One of the records to be kept in the project records is the result of user acceptance testing (IEEE, 2006a).

101. Question: Are the results of the UAT test approved? Who approves? Are the results of the UAT documented?

Current status of Bank A: Bank A employs an approval indicating that it is appropriate to perform a transition to production environment due to positive results of user acceptance testing. This approval is given by test

responsible within test group at the business end. On the other hand, results of user acceptance testing are documented and stored in the project folders at Bank A.

Current status of Bank B: Results of user acceptance tests are approved by internal customers and project manager at Bank B. Moreover, results of user acceptance tests are documented and retained at Bank B.

Current status of Bank C: Bank C currently does not have a recording and approval mechanism for the results of user acceptance tests.

Problem: Results of user acceptance tests are not documented and approved at Bank C as suggested by IEEE Standard 1074.

Expected situation: IEEE Standard 1074 (2006a) mentions software installation activities and this question is an extension of Question 89. There are two questions regarding the transfer of software packages. Because, software transfer from development to test environment and from test to production environment must be segregated by the companies. This question deals with the second part of the transfer process namely from test environment to the production environment. Further reference is not given as this question refers to the same part of the standard used in Question 89.

102. Question: Which organizational unit is responsible of transferring the software components from test system to production environment? Which conditions are asked to perform the transfer?

Current status of Bank A: Change management unit is responsible of software transfer from test environment to production environment at Bank A. Bank C seeks out user acceptance test result approval to perform software transfer to production environment. Moreover, transition to

production environment is not performed at specific dates such as beginning of the month, at the middle of the month, and at the end of the month.

Current status of Bank B: Test team within software development management unit prepares releases following approval of user acceptance tests at Bank B. After package preparation test team enters transfer work request to ClearQuest tool. According to the specifications in the request, software is transferred to production environment by data processing management unit personnel.

Current status of Bank C: Operation unit is responsible of package transfer to production environment at Bank C. Bank C creates work requests to perform software transfer at its service management system, transfer requests are approved, and transfer is performed by operation staff. Bank C's predecessor to perform the transfer is positive accomplishment of acceptance tests.

Problem: No problem has been identified for this question.

Expected situation: In the Operation and Support Activity Group of IEEE Standard 1074 a specific activity has been defined which is named Operate the System. This activity gives a brief activity description regarding operation of the system. According to this definition, installed software should be utilized in the intended environment in accordance with the operating instructions (IEEE, 2006a).

103. Question: Which organizational unit operates the production environment? How?

Current status of Bank A: Change management unit is responsible of operating production environment at Bank A. Moreover, system operation

team performs several operations such as batches and queries with the consent of change management unit at production environment.

Current status of Bank B: Operation of production environment is performed by data processing management unit at Bank B. Moreover, production environment and systems are continuously monitored via several tools.

Current status of Bank C: Operation unit is responsible of operating production environment at Bank C. In addition to that, production environment is operated with respect to defined operation processes at Bank C.

Problem: Production environment is not operated using operating instructions or standard operational procedures at Bank A and Bank B as suggested by IEEE Standard 1074.

Expected situation: In the Operate the System activity of IEEE Standard 1074 it is annotated that feedback data is collected for system tuning and product improvement (IEEE, 2006a). This is only applicable where a monitoring process is applied for systems which have recently been promoted to production environment.

104. Question: Is the system at the implementation stage monitored for some time in case of errors?

Current status of Bank A: Bank A monitors newly implemented systems with respect to decisions taken at project meetings. Monitoring new systems is a standard phase to be implemented between transition to production and project closure at Bank A.

Current status of Bank B: Bank A also monitors newly implemented systems with a monitoring time according to scale of applications, and risks related to the project. Moreover, monitoring process is performed by software development department that has developed the software or business unit that is the actual user of the system.

Current status of Bank C: Bank C has a formal monitoring phase to monitor newly implemented systems for problems which is followed by project close-out phase.

Problem: No problem has been identified for this question.

Expected situation: In the System Operation activity of Operation Process in IEEE/EIA Standard 12207.0, it is indicated that procedures for receiving, resolving, tracking problems should have been established by the organization (IEEE& EIA, 1996).

105. Question: Has the company established procedures related to the problems encountered at the operation environment during and after implementation?

Current status of Bank A: Bank A is currently at the preparation phase of a problem management procedure using CMMI process guidelines. Current problems at the production environment are announced by business units and problem records are created by central support management unit of Bank A.

Current status of Bank B: Bank B has established problem management procedures for the resolution of problems encountered at the production environment. Procedure is related to three levels of organization where call centers are in the first level, problem management group within

software development management unit is in the second level, and experts are in the third level of problem resolution.

Current status of Bank C: Bank C currently does not have a formal problem management process to handle problems encountered at the production environment. Problems at the production environment are analyzed and if it is evaluated as a fault by software development unit, related software component is fixed at Bank C. But, change requests related to problems are recorded in the service management system.

Problem: Formal problem management procedures to handle problems encountered at production environment are not created by Bank A and Bank C as suggested by IEEE/EIA Standard 12207.0.

Expected situation: In the Process Implementation activity of Operation Process of IEEE/EIA Standard 12207.0, it is suggested that whenever problems are encountered they should be recorded and further investigated for resolution (IEEE& EIA, 1996).

106. Question: Does the company keep track of the problems encountered at the operation environment during implementation?

Current status of Bank A: If problems are encountered during planned implementations, Bank A creates relational records at SAP problem management software.

Current status of Bank B: Bank B does not keep track of problems encountered during implementation at production environment.

Current status of Bank C: Bank C creates problem records at its service management system if problems are encountered during implementation at production environment. First of all, implementations at

production environment are performed with respect to service management system requests and records. If any problem occurs, problems are associated with transfer records and sent to related units.

Problem: Bank B does not keep track of problems encountered during implementation at production environment as suggested by IEEE/EIA Standard 12207.0.

Expected situation: In the System Operation activity of Operation Process of IEEE/EIA Standard 12207.0, it is suggested that system should be operated with respect to the user documentation (IEEE& EIA, 1996).

107. Question: How does the company ensure that the implemented system is operated according to the user documentation?

Current status of Bank A: Bank A does not have an organizational unit or mechanism that verifies that the implemented system is operated according to the user documentation.

Current status of Bank B: Branch operations and user guides are published at Bank B's internal portal. Moreover, organization management unit ensures that documents and guides within the portal up-to-date at Bank B.

Current status of Bank C: Firstly, operational users and end-users are trained at Bank C. In addition to that, internal audits performed within the organization and periodical automatic control programs report faulty usage of systems.

Problem: Bank A does not have an organizational unit or mechanism that verifies that the implemented system is operated according to the user documentation as suggested by IEEE/EIA Standard 12207.0.

Expected situation: IEEE/EIA Standard 12207.0 suggests that company should provide assistance and consultation to system users when necessary (IEEE& EIA, 1996).

108. Question: Does the company provide assistance to system users when necessary? Which organizational unit is responsible for the assistance?

Current status of Bank A: Central support management unit provides personal computer (PC) support and application support to end-users at Bank A. Moreover, applications used at the bank have their own help menus and training materials are sent to bank branches for bank operation staff.

Current status of Bank B: Bank B has built a three level support for system users where call centers are in the first level, problem management group within software development management unit is in the second level, and experts are in the third level of problem resolution. Moreover, branch operations and user guides are published at Bank B's internal portal.

Current status of Bank C: Bank C has established a two level assistance mechanism for system users where helpdesk is in the first level and monitoring support, automated teller machine (ATM) monitoring and support, system management, and user authorization are in the second level of assistance.

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 1062 suggests that supplier performance should be evaluated after the acceptance of software and performance data should be retained for future reference (IEEE, 1998b).

109. Question: How is the supplier performance evaluated for acquired software?

Current status of Bank A: Bank A uses standard evaluation criteria to rate supplier performance such as support provided by the supplier, product performance, and problem resolution. Bank A performs yearly supplier evaluation with questionnaires including these criteria.

Current status of Bank B: Supplier performance is evaluated in the dimensions of compliance to time and cost plans, compliance to Bank B's processes, and compliance of deliverables to predefined software specifications.

Current status of Bank C: Bank C performs evaluation for supplier performance. But, bank does not use specific criteria to perform supplier evaluation. It has been stated that after the completion of current CMMI process improvements, supplier performance will be evaluated using several aspects such as communication, delivery, and technical competence.

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 1063 provides minimum requirements for the structure, information content and format of user documentation (IEEE, 2001b). Although, process based constraints are not mentioned in the standard, it is essential to build user documentation procedures to enforce timely documentation and users' early adaptation to new systems.

110. Question: Does the company have policies/procedures related to software user documentation?

Current status of Bank A: Draft user guide prepared at the end of the analysis phases turns into user guide at the migration to production at Bank A. However, Bank A does not have procedures related to software user documentation and user documentation process is carried out with best practices.

Current status of Bank B: Bank B has a documentation process indicating which documents to produce and when to produce within the process. Moreover, Bank B has created documentation templates for the audiences which guide authors in terms of content and rules of user documentation.

Current status of Bank C: As a principle, Bank C does not perform production phase before the completion of user documentation. Moreover, bank has corporate documentation standards indicating format, content of user documentation.

Problem: Bank A does not have procedures related to software user documentation as suggested by IEEE Standard 1063.

Expected situation: In order to ensure timely delivery of documentation IEEE Standard 1074 suggests that a documentation plan should be developed in the project planning activities (IEEE, 2006a). Standard also guides that documentation plan should include responsibilities, information sources, resource allocations, and intended audiences.

111. Question: How does the company ensure that user documentation is completed in a timely manner?

Current status of Bank A: Timely delivery of user documentation is enforced and followed by project manager and quality assurance representative at Bank A. It is required to complete user documentation before migration to production as a practice of the company.

Current status of Bank B: Bank B follows up timely delivery of user documentation using quality assurance activities that are included in the project management plan and compliance to existing processes.

Current status of Bank C: Analysis team leader is responsible of following progress and timely delivery of user documentation. Moreover, user documentation status is followed at project progress meetings at Bank C.

Problem: No problem has been identified for this question.

Expected situation: IEEE/EIA Standard 12207.0 defines documentation process as a support process of software life cycle primary processes. In the process implementation step of documentation process standard defines procedures for several aspects of documentation such as inputs, development, review, modification, approval, production, storage, distribution, and maintenance (IEEE& EIA, 1996).

112. Question: Does the company have a documentation procedure to be used throughout the system development life cycle?

Current status of Bank A: Although Bank A does not have procedures related to several aspects of user documentation; issues related to documentation are controlled using several practices and company has created guidance templates for documentation. Inputs, development, approval, production, modification of documentation is included in

company's system development process. However, review of user documentation is performed by software development unit and company is currently preparing process documentation for storage and distribution of documents. Finally, company does not have a process related to maintenance of user documentation.

Current status of Bank B: Bank B's system development process cover all the aspects related to user documentation as suggested by the standard. Moreover, company has created a documentation procedure that covers all issues that are guided by the standard.

Current status of Bank C: Bank C retains several aspects of user documentation at its corporate portal. Inputs to documentation are recorded within requirement analysis document, development of documentation resides within technical design document, and review report for system development process includes user documentation. Moreover, modification of documentation is performed via change logs, and documents are prepared using corporate predefine formats in the process. Finally, storage, distribution, and maintenance of documentation are performed using corporate portal at Bank C.

Problem: Bank A does not have process documentation for storage, distribution, and maintenance of user documentation.

Problem: Procedures related to user documentation to guide documentation process are not prepared at Bank A and Bank C.

Expected situation: IEEE Standard 1074 defines maintenance activities under the Post-Development Activity Groups. Standard does not address a specific unit or workgroup for the maintenance but defines

activities for the maintenance process which is required throughout system life cycle (IEEE, 2006a).

113. Question: Which organizational unit is responsible of the system maintenance?

Current status of Bank A: Bank A does not perform maintenance for enhancement of the systems until there is a request for maintenance.

Software maintenance is performed by software development staff to fix software bugs, and problems.

Current status of Bank B: Maintenance of software is performed by application development units which are under software development management unit at Bank B.

Current status of Bank C: Software development unit and business analysis units are responsible of software maintenance at Bank C.

Problem: No problem has been identified for this question.

Expected situation: IEEE/EIA Standard 12207.0 suggests that companies should establish procedures for several aspects of problem reporting, and modification requests (IEEE& EIA, 1996).

114. Question: Has the company established procedures for receiving, recording, and tracking problem reports and modification requests from the users and providing feedback to the users?

Current status of Bank A: Bank A has established problem management process regarding receiving, recording, and tracking problem reports and modification requests from the users and providing feedback to the users. However, procedures that support problem management process have not been created within the organization.

Current status of Bank B: Bank B gets modification requests using an automated tool and requests are prioritized with the business users. Moreover, user guides have been created as procedures to provide assistance to users for using these interfaces.

Current status of Bank C: Bank C has created procedures regarding receiving, recording, and tracking problem reports and modification requests from the users and providing feedback to the users. Moreover, Bank C performs management and follow-up of problems using its service management system.

Problem: Procedures regarding receiving, recording, and tracking problem reports and modification requests from the users and providing feedback to the users does not exist at Bank A as suggested by IEEE/EIA Standard 12207.0.

Expected situation: ISO/IEC Standard 14764 and IEEE Standard 14764 suggest that a maintenance plan should be developed to use during maintenance process (ISO& IEC& IEEE, 2006b). However, standard guides that maintenance plan should document company's strategy to maintain the system.

115. Question: Does the company prepare maintenance plans for the system development projects?

Current status of Bank A: Bank A takes maintenance plans into consideration if maintenance effort requires resources higher than 40 men a day. This type of maintenance is followed as a project and maintenance plans are created for the project.

Current status of Bank B: Bank B prepares operational guidelines if a project migrated to production stage requires operational support in the system development process.

Current status of Bank C: If change requests triggered by management reach to a specific level due to legal, regulatory, and technological changes, Bank C prepares maintenance plans and manages maintenance projects.

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 1219 has divided software maintenance into seven phases first of which is Problem/modification identification, classification, and prioritization. In this step, it is given that input of a problem is a maintenance request and it should be stored in a repository by a unique identifier (IEEE, 1998h).

116. Question: How is maintenance requests generated in the maintenance process?

Current status of Bank A: Small screen change requests are requested to project managers using a tool at Bank A. Moreover, changes that require resources higher than fourty men a day are sent as maintenance project requests to project managers via an automated tool at Bank A.

Current status of Bank B: Maintenance requests are created by business end using an automated system at Bank B and stored at another system.

Current status of Bank C: Change requests that are created by business and or management due to legal, regulatory, and technological changes are stored at service management system at Bank C.

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 1219 has divided software maintenance into seven phases first of which is Problem/modification identification, classification, and prioritization. In this step's process definition, it is given that every maintenance request should be classified and prioritized along the process (IEEE, 1998h).

117. Question: How is the maintenance requests generated, classified and prioritized?

Current status of Bank A: Maintenance requests that require resources higher than fourty men a day are classified in the request pool by business units. IT department prioritizes request through consultation with the business unit and with respect to resource quota on hand.

Current status of Bank B: Bank B firstly performs an analysis to estimate scale of maintenance and requests are prioritized by collaborating with business units.

Current status of Bank C: Bank C takes legal and regulatory changes as the highest priority among maintenance requests. In addition to that, change requests that require performance enhancements rank in the second priority range of requests. Finally, positive enhancements that cut off business practice costs reside within third priority level at Bank C.

Problem: No problem has been identified for this question.

Expected situation: ISO/IEC Standard 14764 and IEEE Standard 14764 divide maintenance process into six phases second of which is problem and modification analysis. This sub process suggests organizations to document maintenance requests and results.

118. Question: How does the company record/document maintenance requests?

Current status of Bank A: Bank A records maintenance requests in a request pool and requests are transferred to Lotus Notes to execute the maintenance process. Moreover, requests in Lotus Notes are forwarded to associated project managers by business units.

Current status of Bank B: Bank B gets modification requests using an automated tool and requests are recorded in another system to execute the maintenance process.

Current status of Bank C: Recorded change requests at Bank C's service management system are analyzed by business analysis unit. If business analysis unit reaches a decision to get maintenance request into the scope of maintenance projects, requests are filtered and requirements analysis document is created to start the maintenance process.

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 1219 suggests performing feasibility study in several dimensions such as impact of modification, alternate solutions, analysis of modification requirements, safety and security issues, human factors, short and long-term costs, and value of performing the modification (IEEE, 1998h).

119. Question: Is feasibility for maintenance requests prepared?

Current status of Bank A: Bank A prepares feasibility in all dimensions suggested by the standard if maintenance effort requires higher resources than fourty men a day. Bank does not require preparing feasibility for smaller modifications.

Current status of Bank B: Application development unit makes an effect analysis after receiving the maintenance request. If the request is considered as a detailed request and effort, change management process is applied and this includes all the aspects that are suggested by the standard.

Current status of Bank C: Bank C performs feasibility study in all the dimensions suggested by the standard except alternate solutions, classification of maintenance, and identification of ripple effects.

Problem: Feasibility study performed for maintenance requests does not contain alternate solutions, classification of maintenance, and identification of ripple effects at Bank C as suggested by IEEE Standard 1219.

Expected situation: IEEE Standard 1219 has divided software maintenance into seven phases second of which is analysis phase. In this step's process definition, standard suggests to perform a detailed analysis in several dimensions including identification of modification elements (IEEE, 1998h).

120. Question: Is a detailed analysis performed to define requirements of the firm to identify elements of the modification (documentation, code, and database) and portions of the modification on these elements?

Current status of Bank A: Bank A executes standard system development process for maintenance request that require higher resources than fourty men a day. Nevertheless, elements of modification are defined in the analysis and development phases.

Current status of Bank B: Application development unit makes an effect analysis after receiving the maintenance request. If the request is considered as a detailed request and effort, change management process is applied and elements of modification are analyzed in the change management process.

Current status of Bank C: Effect analysis performed by version management group at Bank C corresponds to analysis of modification suggested by the standard.

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 1219 suggests to perform a detailed analysis in several dimensions and to develop an initial implementation plan (IEEE, 1998h). Standard also guides that initial implementation plan should state how the design, implementation, testing, and delivery of the modification will be performed by the organization to ensure minimal impact to current users.

121. Question: Is a preliminary implementation plan created to ensure a minimal impact to current users?

Current status of Bank A: Bank A generally publishes internal circular letters and e-mails are sent to system users following major modifications in existing systems. However, impact of change to current users is evaluated within the feasibility study performed for the modification.

Current status of Bank B: Application development unit makes an effect analysis after receiving the maintenance request. If the request is

considered as a detailed request and effort, change management process is applied and impact to current users is evaluated within the process.

Current status of Bank C: Bank C mostly performs pilot deployments for major modifications in existing systems. Afterwards, if deployment is successful at pilot locations, modification is applied at all locations. Moreover, impact of change to current users is evaluated within the feasibility study performed for the modification.

Problem: Although impact of change to current users is considered within feasibility study of modification; preliminary implementation plans are not created at Bank A, Bank B, and Bank C to ensure minimal impact of modification on current users as suggested by IEEE Standard 1219.

Expected situation: IEEE/EIA Standard 12207.0 defines a sub process named maintenance review/acceptance under maintenance process, which suggests getting an approval from the users for completeness of maintenance (IEEE& EIA, 1996).

122. Question: Does the maintenance unit ask for approval from the business unit for implementation of the selected modification?

Current status of Bank A: Modifications performed on existing systems are migrated to production with deployment to production approval at Bank A.

Current status of Bank B: If implementation of modification has a direct impact on system users in the dimensions of cost, time, and constraints; IT department asks for an approval from business units using change management process at Bank B.

Current status of Bank C: If the change has an impact on current system users in the dimensions of process change, screen views; IT department asks for an approval from business units to implement the modification at production environment.

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 1219 suggests to perform a detailed analysis in several dimensions and to devise a test strategy. Standard underlines at least three types of tests, namely individual element tests, integration tests, and user-oriented functional acceptance tests, requirements of which should be defined in the test strategy (IEEE, 1998h).

123. Question: Are requirements for testing modification elements defined as a test strategy?

Current status of Bank A: Modifications that require higher resources than fourty men a day are implemented using company's standard system development process at Bank A. So, whole test process is applied to modifications and requirements for unit tests, integration tests, and acceptance tests are defined in the process.

Current status of Bank B: Requirements for unit tests, integration tests, and acceptance tests resulting from maintenance are defined using change management process at Bank B.

Current status of Bank C: Bank C prepares test scenarios in order to test changed portion of software which results from maintenance of systems.

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 1219 suggests that after implementation of the maintenance, as outputs of this phase, test

documentation (test plan, test cases, and test procedures), training and technical documentation, design documentation and user documentation should be updated accordingly (IEEE, 1998h).

124. Question: What actions are taken for documentation change requirements resulting from maintenance? Is the update verified?

Current status of Bank A: As normal system development process is applied for maintenance, all the documentation produced in the system development process such as user guide, design document, requirements definition document is updated in the process at Bank A.

Current status of Bank B: As normal project processes are applied for maintenance, documentation change requirements are followed and performed using quality assurance review and customer approval process.

Current status of Bank C: As Bank C applies normal system development process for maintenance, documentation changes are performed using versioning standards of the organization.

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 1219 has divided software maintenance into seven phases fourth of which is implementation phase. In this step which comes right after the design phase step, it is suggested that one of outputs of this phase should be updated user documentation (IEEE, 1998h).

125. Question: Is software (system/user) documentation updated due to the changes in design resulting from the maintenance?

Current status of Bank A: If the design has changed due to maintenance, draft user guide and user guide are also updated within the

system development process at Bank A. As a practice of company, department that prepares the initial document at system development is responsible of preparing updated user documentation.

Current status of Bank B: As normal project processes are applied for maintenance, documentation change requirements are followed and performed using quality assurance review and customer approval process at Bank B.

Current status of Bank C: As Bank C applies normal system development process for maintenance, documentation changes are performed using versioning standards of the organization and user documentation is updated following the modifications.

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 1219 suggests that software module documentation should be updated and it should be verified that new/updated software design document is created as a result of maintenance (IEEE, 1998h).

126. Question: Is new design document created for the changes in the design resulting from the maintenance?

Current status of Bank A: Updating design document due to design changes is a mandatory issue at Bank A and inspected with internal audits.

Current status of Bank B: Application development unit makes an effect analysis after receiving the maintenance request. If the request is considered as a detailed request and effort, change management process is applied and design documentation is updated within the process.

Current status of Bank C: If maintenance performed on existing systems is a major change and design has changed, new design documents are created at Bank C.

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 1219 suggests that test cases and regression tests for the new design should be created within the maintenance process (IEEE, 1998h).

127. Question: Are test cases for regression testing created for the new design resulting from the maintenance? (If maintenance causes a redesign effort)

Current status of Bank A: Creating new regression tests and test cases for updated design is a mandatory issue in the system development process of Bank A. However, it has been stated that this issue is not strictly controlled within the practices of company.

Current status of Bank B: Application development unit makes an effect analysis after receiving the maintenance request. If the request is considered as a detailed request and effort, change management process is applied and new regression test cases with updated test cases are created within the process.

Current status of Bank C: If maintenance performed on existing systems is a major change and design has changed, new regression tests and new test cases are created at Bank C

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 1219 has divided software maintenance into seven phases fourth of which is implementation phase where change in the source code is performed during maintenance process. Coding and unit testing activity of implementation phase states that after change in the source code is completed, unit tests should be performed by the authors of the change (IEEE, 1998h).

128. Question: Is unit testing performed and documented after coding for the maintenance? Are the results of the unit testing documented?

Current status of Bank A: Bank A performs unit testing at development environment and unit test record form is filled out by executers of the unit tests after significant changes in software design.

Current status of Bank B: Information systems project members perform unit tests at Bank B following the implementation of significant changes resulting from maintenance. However, results of unit tests are not formally documented at Bank B.

Current status of Bank C: Bank C performs unit tests for each updated software component. However, results of unit tests are not formally documented at Bank C.

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 1219 states that after changing the source code for maintenance, integration tests should be performed by integrating the modified software with the system (IEEE, 1998h).

129. Question: Is integration testing performed and documented after coding for the maintenance by integrating the modified software with the system?

Current status of Bank A: Bank A performs integration tests resulting from major changes in the system design. Software developers perform release integration tests and system development unit performs system integration tests after major modifications at existing systems.

Current status of Bank B: Bank B also performs integration tests at every system development project after coding for the maintenance. However, results of integration tests are documented by application test group for some projects.

Current status of Bank C: Bank C performs integration tests for system development projects after coding for the maintenance to identify integration problems. Moreover, results of integration test are recorded in test defect logs.

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 1219 has divided software maintenance into seven phases sixth of which is acceptance test phase where software maintenance with a new design and implementation is accepted by the users of the system. An input for this acceptance process is acceptance test plans which are updated at the analysis, design or implementation phases (IEEE, 1998h).

130. Question: Is acceptance test plan updated with respect to the new design?

Current status of Bank A: Acceptance test plans are generated again for closed projects at Bank A by test unit within the business end.

Current status of Bank B: Application development unit makes an effect analysis after receiving the maintenance request. If the request is

considered as a detailed request and effort, change management process is applied and new acceptance test plans with updated test cases are created within the process if it is asked by the internal customers.

Current status of Bank C: Bank C performs acceptance tests for system development projects after coding for the maintenance to identify problems. Moreover, acceptance tests are performed by business units and system users.

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 1219 suggests that system testing should be performed on the modified and fully integrated system. Standard also guides that results of the test should be reported in the process (IEEE, 1998h).

131. Question: Is system testing performed for the maintenance? Are the results of the system testing documented and reported?

Current status of Bank A: System integration tests are performed by system development unit at Bank A. Moreover, results of system integration tests are documented and stored in the project folders at Bank A.

Current status of Bank B: System tests are performed at Bank B following the coding of maintenance and results of system tests are documented and retained at Bank B.

Current status of Bank C: Bank C performs systems tests for new design and results of system tests are prepared at Bank C. But, Bank C currently does not have a recording mechanism for the results of system tests. Thus, Bank C currently works on standardization of test outputs with

CMMI process improvement project and test outputs will be recorded at service management system.

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 1219 indicates that acceptance test should be performed on a fully integrated system and results of the acceptance test should be reported (IEEE, 1998h).

132. Question: Is acceptance testing performed for the maintenance by the users of the system? Are the results of the acceptance testing reported and retained under SCM?

Current status of Bank A: User acceptance tests are performed by test unit within the business end at Bank A for modifications that require higher resources than forty men a day. Bank A employs an approval indicating that it is appropriate to perform a transition to production environment due to positive results of user acceptance testing. This approval is given by test responsible within test group at the business end. On the other hand, results of user acceptance testing are documented and stored in the project folders at Bank A.

Current status of Bank B: Bank B performs acceptance tests for modifications if it is requested by business end. Moreover, results of user acceptance tests are documented and retained at Bank B.

Current status of Bank C: Acceptance tests are performed for system modifications at Bank C and results are reported to related parties. But, Bank C currently does not have a recording for the results of user acceptance tests.

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 1219 suggests that current working system should be backed up in order to revert back in case of a failure (IEEE, 1998h).

133. Question: Is a backup of the working system taken before installing the maintained new system?

Current status of Bank A: Working and stable backup of a system is taken at Bank A in accordance with the standard procedure of change management.

Current status of Bank B: Configuration management unit performs backup operations before installing the maintained new system at Bank B.

Current status of Bank C: Source codes and executable programs are backed up at Bank C before implementing modifications on working systems.

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 1219 suggests performing training in the customer facility following the installation of maintenance (IEEE, 1998h).

134. Question: Is training provided to system users when the modifications result in significant documentation and system changes?

Current status of Bank A: Maintenance efforts that require higher efforts than forty men a day are taken into consideration as maintenance projects. Moreover, training plans are regenerated and trainings are provided for these projects at Bank A.

Current status of Bank B: Bank B provides trainings to system users if there is a significant change in the system.

Current status of Bank C: Bank C also provides trainings to system users if there is a significant change in the system. Moreover, trainings are provided at training centers if there is few number of users or training documents are shared with system users when there is an excessive number of users.

Problem: No problem has been identified for this question.

Expected situation: IEEE/EIA Standard 12207.0 suggests that maintainer should obtain approval for satisfaction completion of maintenance from the system users (IEEE& EIA, 1996).

135. Question: Does the maintainer obtain approval for the satisfactory completion of the maintenance?

Current status of Bank A: User acceptance test approval is asked from business test unit to perform migration to production at Bank A.

Current status of Bank B: Maintenance requests are entered to request management system and followed by the owners of the request. Approval for completion of maintenance is not obtained from business units at Bank B.

Current status of Bank C: Bank C currently uses different processes that differ according to business units. It has been stated that written approval will be obtained from business units for appropriate completion of maintenance after the completion of current CMMI process improvement project.

Problem: Approval regarding the satisfactory completion of maintenance is not obtained at Bank B and Bank C as suggested by IEEE/EIA Standard 12207.0.

Expected situation: ISO/IEC Standard 14764 and IEEE Standard 14764 divide maintenance process into six phases fifth of which is migration. This phase has an activity called post-operation review which suggests that impact of change to the environment should be assessed in the maintenance process (ISO& IEC& IEEE, 2006b).

136. Question: Does the maintainer perform a post-operation review to assess the impact of the change to the new environment?

Current status of Bank A: Post-operation review is not a mandatory and defined process at Bank A. This process is performed only if developer of the system raises a warning to monitor the system.

Current status of Bank B: Post-operation review is not performed at Bank B.

Current status of Bank C: All the units responsible of maintenance review the system following implementation of maintenance at Bank C. However, post-operation review is not a mandatory and defined process at Bank C.

Problem: Post-operation review process is not established to assess the impact of the change to the new environment at Bank A, Bank B, and Bank C as suggested by ISO/IEC Standard 14764 and IEEE Standard 14764.

Expected situation: IEEE/EIA Standard 12207.2 suggests that it should be verified that selected processes for project life cycle are executed and implemented (IEEE& EIA, 1997).

137. Question: How does the company ensure that company's practices comply with defined system development process for the projects?

Current status of Bank A: Quality assurance responsible of a specific project inquires outputs between project stages at Bank A to assess compliance to existing processes.

Current status of Bank B: Quality assurance unit performs reviews in terms of documentation and execution of processes to measure and verify compliance to existing processes at Bank B.

Current status of Bank C: Bank C performs project progress meetings interval of which is defined according to project duration. Project's progress status, and performed tasks are evaluated at these meetings. It has been stated that after the completion of current CMMI process improvement project there will be a more formal review process using predefined rules.

Problem: Bank C does not have a formal mechanism to verify that company's practices comply with defined system development process for the projects as suggested by IEEE/EIA Standard 12207.2.

Expected situation: In IEEE Standard 1028's management preparation section, it is suggested that managers should ensure that reviews are performed as required by existing policies for both management and technical reviews (IEEE, 1997).

138. Question: Does the company have a review policy for management and technical reviews?

Current status of Bank A: Bank A has prepared review policies for management and technical reviews.

Current status of Bank B: Bank B has prepared policies for management and technical reviews.

Current status of Bank C: Bank C has prepared policies for management and technical reviews.

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 1028's management preparation section suggests that managers should ensure that reviews are performed as required by existing company procedures for both technical and managerial reviews (IEEE, 1997).

139. Question: Does the company have technical and management review procedures?

Current status of Bank A: Bank A has documented technical and management review procedures to be used throughout the system development process.

Current status of Bank B: Bank B has documented technical and management review procedures to be used throughout the system development process.

Current status of Bank C: Bank C has documented its process regarding meetings to be performed with management, technical design meetings, and informative meetings. Standard presentations are prepared for these meetings and minutes of meetings are recorded and shared with participants. In addition to that, it has been stated after the completion of current CMMI process improvement project, review plans, review checklists, review rules will be defined and there will be a standard review process for managerial and technical reviews.

Problem: Procedures related to managerial and technical reviews are not documented at Bank C as suggested by IEEE Standard 1028.

Expected situation: IEEE Standard 1028 defines five types of reviews one of which is management review. Standard defines aim of management review as to monitor progress, determine the status of plans and schedules, confirm requirements and their system allocation, or evaluate the effectiveness of management approaches used to achieve fitness for purpose (IEEE, 1997).

140. Question: Is management review taking place during system development life cycle?

Current status of Bank A: Management reviews are taking place for several software products and aspects at Bank A.

Current status of Bank B: Management performs various reviews for software products at Bank B.

Current status of Bank C: Management reviews take place at several phases within the system development process at Bank C such as project scope presentations, technical design meetings, and project progress meetings. Moreover, it has been stated after the completion of current CMMI process improvement project there will be a standard review process for managerial reviews.

Problem: No problem has been identified for this question.

Expected situation: In the management review section of IEEE Standard 1028 software products subject to management review are provided by the standard (IEEE, 1997). Standard has listed following products for management reviews:

- Anomaly reports
- Audit reports

- Back-up and recovery plans
- Contingency plans
- Customer or user representative complaints
- Disaster plans
- Hardware performance plans
- Installation plans
- Maintenance plans
- Procurement and contracting methods
- Progress reports
- Risk management plans
- Software configuration management plans
- Software project management plans
- Software quality assurance plans
- Software safety plans

141. Question: Which of the following software products are subject to management review?

Current status of Bank A: Anomaly reports, audit reports, back-up and recovery plans, contingency plans, disaster plans, hardware performance plans, procurement and contracting methods, progress reports, risk management plans, and software project management plans are subject to management review at Bank A. But, customer and user representative complaints, installations plans, maintenance plans, software configuration management plans, software quality assurance plans, and software safety plans are not subject to management review at Bank A.

Current status of Bank B: Anomaly reports, audit reports, customer and user representative complaints, progress reports, risk management plans, software project management plans, and software quality assurance plans are subject to management reviews at Bank B. However, back-up and recovery plans, contingency plans, disaster plans, hardware performance plans, installation plans, maintenance plans, procurement and contracting methods, software configuration management plans, and software safety plans are not subject to management reviews at Bank B.

Current status of Bank C: It has been stated that all of the plans suggested by the standard are subject to management review at Bank C.

Problem: Installation plans, maintenance plans, software configuration management plans, and software safety plans are not subject to management reviews at Bank A and Bank B as suggested by IEEE Standard 1028.

Problem: Customer and user representative complaints and software quality assurance plans are not subject to management review at Bank A.

Problem: Back-up and recovery plans, contingency plans, disaster plans, procurement and contracting methods, and hardware performance plans are not subject to management review at Bank B as suggested by IEEE Standard 1028.

Expected situation: IEEE Standard 1028 does not provide a specific authority for the management review but it defines some qualifications for management review such as having direct responsibility for the system, having technical knowledge, being qualified to evaluate the software product (IEEE, 1997).

142. Question: Who is responsible of management review for system development projects?

Current status of Bank A: IT Executive management composed of assistant general manager, five IT directors, and managers of IT subdivisions are responsible of management reviews at Bank A.

Current status of Bank B: Management reviews are performed by project coordinators at Bank B. Project managers are subordinates of project coordinators, and project coordinators ensure coordination with other project managers, management, and other units.

Current status of Bank C: Technical committee composed of general manager, assistant general manager, and unit managers perform management reviews for large and middle scale system development projects. Moreover, project manager, team leader, and unit managers of software development and analysis perform management review for small scale system development projects at Bank C.

Problem: No problem has been identified for this question.

Expected situation: Set of software products subject to technical review are provided in the technical review section of IEEE Standard 1028 (IEEE, 1997). Standard has provided below list of products which should be subject to technical reviews:

- Software requirements specification
- Software design description
- Software test documentation
- Software user documentation
- Maintenance manual

- System build procedures
- Installation procedures
- Release notes

143. Question: Which software products are subject to technical review?

Current status of Bank A: Bank A does not have a formal and general rule that enforces review of prepared documents by more experienced peers. This issue is considered by departments at their own initiative for software products. But, source code is reviewed by more experienced peers as a general rule at Bank A.

Current status of Bank B: Software requirements specification, software design description, software test documentation are subject to quality assurance review at Bank B. However, software user documentation, maintenance manual, system build procedures, installation procedures, and release notes are not subject to technical reviews at Bank B. But, it has been stated that technical review team will be established to ensure proper implementation of technical reviews.

Current status of Bank C: Software requirements specification document, software design description document, software user documentation, and source code are subject to technical reviews at Bank C. However, software test documentation, maintenance manual, system build procedures, installation procedures, and release notes are not subject to technical reviews at Bank C.

Problem: Technical review process is not formally executed at Bank A and Bank B as suggested by IEEE Standard 1028.

Problem: Maintenance manual, system build procedures, installation procedures, and release notes are not subject to technical reviews at Bank B and Bank C.

Problem: Software user documentation is not subject to technical review at Bank B.

Problem: Software test documentation is not subject to technical review at Bank C.

Expected situation: IEEE Standard 1028 does not provide a specific authority, but it defines some roles for the technical reviews such as decision maker, review leader, recorder, and technical staff (IEEE, 1997).

144. Question: Who is responsible of technical reviews for system development projects?

Current status of Bank A: Technical review is performed by more experienced peers for software products at Bank A. A typical example of technical review is peer evaluation process where source code of a developer is verified by more experienced peers in the process in terms of compliance to software development standards on several platforms such as Java, COBOL.

Current status of Bank B: Technical reviews are performed by quality assurance staff at Bank B.

Current status of Bank C: Technical reviews are performed by a combination of profiles such as project leader, software development team leader, analysis team leader, risk manager, configuration manager, and quality manager at Bank C.

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 1061 provides a framework for software quality metrics. This methodology for software quality metrics is stated to allow organizations validation of software quality requirements quantitatively. However, this standard does not mandate specific metrics to be used for the software life cycle but provides a framework for metrics definition process. Instead of that, standard indicates that in order to assess software quality, proper metrics should be defined according to desired software quality attributes (IEEE, 1998e).

145. Question: Are there any software quality metrics used throughout the system development life cycle to assess software quality requirements and software deficiencies?

Current status of Bank A: Bank A has implemented corporate standards for software quality metrics. Moreover, defined system development processes have performance indicators and threshold values.

Current status of Bank B: Bank B has defined project metrics using its project management tool which is called measurement and analysis process. Examples of metrics within this process are project workforce performance, milestone time deviation, project requirements change, project productivity, quality assurance performance, design complexity indicator, and fault density.

Current status of Bank C: Bank C has implemented several software quality metrics such as IT project ratios controlled with quality assurance, ratio of IT personnel that has attended quality management trainings, ratio of processes with quality control, ratio of stakeholders in quality surveys, ratio of defects before migration to production, monthly decrease of critical

problems per personnel, ratio of projects inspected and approved by quality group, and ratio of processes inspected and approved by quality group.

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 1061 provides a framework for software quality metrics. The very first step of this framework is to define software quality of a system. So, standard indicates that system quality target and requirements of an organization should be separately set for each system in the beginning (IEEE, 1998e).

146. Question: What is the system quality target of the organization for system development?

Current status of Bank A: Firstly, Bank A has defined quantitative project quality targets. Ratio of acceptance test duration to total project duration should not exceed %20 and project's effort and duration deviation should not be larger than %25. Verbal quality target of the organization is meeting customer expectations by delivering rapid, uninterrupted, reliable products and services.

Current status of Bank B: Bank B's quality target is application of corporate processes at every project and enhancing the processes by performing timely measurements.

Current status of Bank C: Bank C has established several quality targets such as ability of solution to respond to all of customer requirements, solidity of technical infrastructure of solution against technological changes, ability of solution to respond to new business needs with minimum changes, and ability of managing solution independent from developers of the solution. Moreover, ability of implementing small changes on solution

independent from developers, erroneous migration to production, using existing corporate standards during solution development, having the solution with best technical performance, ability to prove solution's correspondence to business need, complete and accurate documentation of solution are other system quality targets of Bank C.

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 1061 provides a software quality metrics methodology. The very first step of this methodology is to establish a set of quality requirements for a system. So, standard suggests defining software quality separately for each system and breaking down each requirement to the factors that can measure it in units (IEEE, 1998e).

147. Question: How does the organization define software quality?

Current status of Bank A: Delivery of requested product at planned date, with all defined requirements, without errors and with extreme quality is the definition of software quality at Bank A.

Current status of Bank B: Improvement of processes by verification of software's compliance to existing processes to minimize software errors is the definition of software quality at bank B.

Current status of Bank C: According to Bank C, quality is solving business requirements of customers in accordance with targeted conditions and ability to be more successful at each solution development than the previous development.

Problem: No problem has been identified for this question.

Expected situation: IEEE Standard 1028 defines five types of software reviews one of which is inspection (IEEE, 1997). Furthermore,

standard provides list of software products that should be inspected by the organizations such as:

- Software requirements specification
- Software design description
- Source code
- Software test documentation
- Software user documentation
- Maintenance manual
- System build procedures
- Installation procedures
- Release notes

148. Question: Are software products subject to internal inspections?

Current status of Bank A: Internal inspections are performed on software requirements specification documents, software design description documents, and source code by quality assurance staff at Bank A. However, software test documentation, software user documentation, maintenance manuals, system build procedures, installation procedures, and release notes are not inspected at Bank A along the system development process.

Current status of Bank B: Software requirements specification documents, software design description documents, source code, software test documentation, project management plans, project definition document, and business requirements definition documents are inspected along the process at Bank B. However, software user documentation, maintenance manuals, system build procedures, installation procedures, and release notes are not inspected at Bank B.

Current status of Bank C: Internal audits at Bank C are performed via internationally accepted IT audit methodologies and CoBit framework is used as a reference document at internal audits. Moreover, software design description documents, source code, software test documentation, installation procedures, and release notes are subject to internal inspections. But, software requirements specification documents, software user documentation, maintenance manual, and system build procedures are not subject to internal inspections.

Problem: Software user documentation, maintenance manuals, system build procedures are not subject to internal inspections at Bank A, Bank B, and Bank C as suggested by IEEE Standard 1028.

Problem: Release notes and installation procedures are not subject to internal inspections at Bank A and Bank B as suggested by IEEE Standard 1028.

Problem: Software requirements specification documents are not subject to internal inspections at Bank C as suggested by IEEE Standard 1028.

Problem: Software test documentation is not subject to internal inspections at Bank A as suggested by IEEE Standard 1028.

Expected situation: IEEE Standard 1028 defines five types of software review one of which is walk-through (IEEE, 1997). Furthermore, standard indicates software products on which walk-through should be performed such as

- Software requirements specification
- Software design description

- Source code
- Software test documentation
- Software user documentation
- Maintenance manual
- System build procedures
- Installation procedures
- Release notes

149. Question: Are software products subject to walk-through?

Current status of Bank A: Software products are not subject to walk-through at Bank A.

Current status of Bank B: Software products are not subject to walk-through at Bank B.

Current status of Bank C: Software products except source code are not subject to walk-through at Bank B.

Problem: Software products are not subject to walk-through at Bank A, Bank B, and Bank C as suggested by IEEE Standard 1028.

Expected situation: IEEE Standard 1074 divides software project life cycle into five activity groups fifth of which is Support Section of Activity Groups. A sub process of this activity defines post-implementation review as the last type of review to be implemented throughout the project life cycle (IEEE, 2006a). Standard also defines post-implementation review as comparison of all planning information with the actual results to determine any improvements needed in such areas as resource utilization, return on investment, and quality system.

150. Question: Is post implementation review performed by the organization?

Current status of Bank A: Bank A prepares project dashboard at the project close-out which compares planned items versus actual items such as costs, efforts, success, resources, and objectives.

Current status of Bank B: Bank B prepares project evaluation at the project close-out which compares planned items versus actual items such as costs, efforts, success, resources, and objectives.

Current status of Bank C: Bank C currently does not perform post-implementation review to compare planned issues to actual results. But, it has been stated that after the completion of current CMMI process improvement project, a close-out report will be prepared which contains all the aspects suggested by the standard.

Problem: Post-implementation review is not performed by Bank C to compare project planning information to actual project results as suggested by IEEE Standard 1074.

Expected situation: IEEE/EIA Standard 12207.2 suggests several dimensions of verification that can be used throughout the system development life cycle such as contract verification, process verification, requirements verification and design verification. Standard also provides detailed guidelines related to these several verification categories (IEEE& EIA, 1997).

151. Question: Does the company employ a verification process?

Current status of Bank A: Contract verification and requirement verification are performed along the system development life cycle at Bank

A. However, process verification and design verification are not performed by Bank A as suggested by the standard.

Current status of Bank B: Contract verification, process verification, and requirements verification is performed at Bank B. But, design verification is not performed completely as suggested by the standard.

Current status of Bank C: Bank C currently does not perform contract verification, process verification, requirements verification, and design verification. However, it has been stated that after the completion of current CMMI process improvement project, all verifications suggested by the standard will be executed using corporate checklists.

Problem: Design verification is not performed by Bank A, Bank B, and Bank C as suggested by IEEE/EIA Standard 12207.2.

Problem: Process verification is not performed by Bank A and Bank C as suggested by IEEE/EIA Standard 12207.2.

Problem: Contract verification and requirements verification are not performed by Bank C as suggested by IEEE/EIA Standard 12207.2.

Problem List

After discussing current process conditions of banks, below table (Table 7) summarizes problems that have been identified with respect to IEEE system development and software engineering standards.

Table 7: Problem List

No	Problem	Phase	Standard/Section	Bank(s)
1	Managerial process plans suggested by the standard are not created completely by the banks.	Project management	IEEE Standard 1058/ 4	A, B, C
2	Project management plans are not managed by a formal configuration management approach	Project management	IEEE Standard 1058/ 4.1.2	A, C
3	Project control plans covering metrics, reporting mechanisms, and control procedures are not created	Project management	IEEE Standard 1058/ 4.5.3	A, B, C
4	Project progress is not measured using estimated plans and actual results	Project management	IEEE Standard 1074/ A.1.3.2.2	B, C
5	Risk management planning is not performed for information systems projects	Project management	IEEE Standard 1058/ 4.5.4	C
6	Technical process plans covering development process model, technical methods, tools, and techniques are not completely created	Project management	IEEE Standard 1058/ 4.6	A, C
7	Subcontractor management plans are not created within project management plan	Project management	IEEE Standard 1058/ 4.7.7	C
8	Subcontractor selection criteria are not specified in the subcontractor management plan	Project management	IEEE Standard 1058/ 4.7.7	B, C
9	Bank does not create separate documentation plans as suggested by the standard	Project management	IEEE Standard 1074/ A.1.2.5	B
10	Bank does not create documentation and training plans as suggested by the standard	Project management	IEEE Standard 1074/ A.1.2.5, A.1.2.6	C
	Types of risk analysis required in the risk management process are not documented	Project management	IEEE Standard 1540/ 5.1.1.1	A, C
11	Stakeholder perspectives supported by the risk management process are not documented within the risk management process	Project management	IEEE Standard 1540/ 5.1.1.1	A
12	Chronological record of each risk's state is not stored	Project management	IEEE Standard 1540/ 5.1.2.3	B
13	Results of risk monitoring process are not reported to project stakeholders	Project management	IEEE Standard 1540/ 5.1.5	A, B
14	Evaluation of risk management process for its efficiency and deficiencies is not performed	Project management	IEEE Standard 1540/ 5.1.6	A

No	Problem	Phase	Standard/Section	Bank(s)
15	Bank has to ponder scale of projects when implementing agile methodologies as agile models are hard to apply to large scale projects because of its lack of architecture planning and overfocusing on early results.	System development	Literature review	A
16	Bank has to consider tailoring Waterfall methodology or, changing the nature of %50 requirements from fast-changing to concrete for project success.	System development	Literature review	C
17	Banks don't have a software acquisition strategy for acquiring off-the-shelf products.	Feasibility	IEEE Standard 1062/ 5.1	A, C
18	Feasibility study is not performed covering all corporate feasibility requirements	Feasibility	IEEE Standard 1074/ A.2.1.3	B
19	Bank currently does not have project metrics to measure several aspects of project success	Analysis	IEEE Standard 1074/ A.1.1.4	C
20	Bank does not have a formal approval process if software requirements analysis is performed by a supplier.	Analysis	IEEE/EIA Standard 12207.0/ 5.1.1.3	C
21	SRS documents prepared by Bank do not cover performance and attribute issues.	Analysis	IEEE Standard 830/ 4.1	B
22	Technical community is not included in the requirements specification phase	Analysis	IEEE Standard 1233/ 5.3	B
23	Customer requirements are not classified by the Bank.	Analysis	IEEE Standard 1233/ 6.3	C
24	A formal change process is not applied to track and control changes on SRS documents	Analysis	IEEE Standard 830/ 4.5	A, C
25	Bank's SRS documents include design requirements which is against the situation suggested by the standard	Analysis	IEEE Standard 830/ 4.7	A
26	Software requirements specifications are not approved in a routine manner	Analysis	IEEE Standard 1074/ A.3.1.2.2	C
27	Quality requirements of a system are not clearly stated at the project outset	Analysis	IEEE Standard 1061/ 3	A
28	Software reviews, tests, problem reporting and corrective actions, supplier control, records collection maintenance and retention, training, risk management, glossary, quality assurance change procedure and history sections suggested by the standard are not created within software quality assurance plans.	Design	IEEE Standard 730/ 4	A, C
29	Design description documents are not formally approved	Design	Waterfall model/ design	A
30	Draft versions of user documentation are not prepared by design staff.	Design	IEEE/EIA Standard 12207.0/ 5.3.5.4	A, C
31	Preliminary versions of test requirements are not prepared by design staff.	Design	IEEE/EIA Standard 12207.0/ 5.3.5.5	A, C
32	Coding and commenting standards and procedures are not in place.	Coding/Package selection	IEEE Standard 1074/ A.3.3.1.2	A, C
33	Operating documents are not prepared to install, to operate, and to support the system.	Coding/Package selection	IEEE Standard 1074/ A.3.3.2.2	B

No	Problem	Phase	Standard/Section	Bank(s)
34	Software configuration management plans are not created along the process.	Coding/Package selection	IEEE Standard 828/ 1.2	A, C
35	Software configuration management policy is not created to be used along the process.	Coding/Package selection	IEEE Standard 828/ 3.2.3	A, B
36	Software configuration management procedure is not created to be used along the process.	Coding/Package selection	IEEE Standard 828/ 3.2.3	A, C
37	Roles and responsibilities for technical and managerial activities of SCM process are not documented by banks.	Coding/Package selection	IEEE Standard 828/ 3.2.2	A, C
38	An overall, detailed release management plan including software release management objectives, including release frequency, release milestones, release media, build procedures and naming conventions, branching models, and delivery media is not prepared by banks as suggested by the standard.	Coding/Package selection	IEEE Standard 1074/ A.1.2.9	A, B, C
39	Access to the software libraries and retrieval of configuration items from software libraries are not governed by formal procedures.	Coding/Package selection	IEEE Standard 828/ 3.3.1.3	A, B, C
40	Banks have not created a standard software acquisition process.	Coding/Package selection	IEEE Standard 1062/ 5.2.1	A, C
41	Each software unit or database development effort is not documented along the process.	Coding/Package selection	IEEE/EIA Standard 12207.0/ 5.3.7	A, B, C
42	Results of unit tests are not formally documented along the process.	Coding/Package selection	IEEE/EIA Standard 12207.0 / 5.3.7	B, C
43	Integration test plans are not prepared for all projects.	Coding/Package selection	IEEE/EIA Standard 12207.0/ 5.3.8 and IEEE/EIA Standard 12207.2/ 5.3.8	B, C
44	Draft versions of user documentation are not prepared in the development process.	Coding/Package selection	IEEE/EIA Standard 12207.0/ 5.3.5.4	B, C
45	Integration plans are not prepared for all system development projects.	Testing	IEEE Standard 1074/ A.1.2.8	A, B
46	Results of integration tests are not documented for all system development projects.	Testing	IEEE/EIA Standard 12207.0/ 5.3.8.2 and IEEE/EIA Standard 12207.2/ 5.3.8.2	B
47	Bank does not have a formal method to keep test environment as much as similar to production environment.	Testing	IEEE Standard 1074/ A.5.1.4	A
48	Problems encountered during installation to test environment are not documented along the process.	Testing	IEEE Standard 1074/ A.4.1.2	A, C
49	Bank does not prepare acceptance test plans including all the aspects suggested by the standard for each system development project.	Testing	IEEE Standard 829/ 4.1	B
50	Test design specification documents are not prepared to specify the test approach and methods to be used and pass/fail criteria for the software features.	Testing	IEEE Standard 829/ 5.1	A, B, C

No	Problem	Phase	Standard/Section	Bank(s)
51	Bank does not prepare test case specification documents at each system development project as suggested by the standard.	Testing	IEEE Standard 829/ 6	B
52	Results of tests performed are not approved by authorized personnel.	Testing	IEEE Standard 829/ 11.2	A, C
53	Bank does not have a defined software acceptance process for subcontractors.	Testing	IEEE Standard 1062/ 5.8.3	C
54	Results of user acceptance tests are not documented and approved along the process.	Testing	IEEE Standard 1074/ A.4.1.3	C
55	Production environment is not operated using operating instructions or standard operational procedures.	Implementation	IEEE Standard 1074/ A.4.2.1	A, B
56	Formal problem management procedures to handle problems encountered at production environment are not created by banks.	Implementation	IEEE/EIA Standard 12207.0/ 5.4.1.2	A, C
57	Bank does not keep track of problems encountered during implementation at production environment.	Implementation	IEEE/EIA Standard 12207.0/ 5.4.1.2	B
58	Bank does not have an organizational unit or mechanism that verifies that the implemented system is operated according to the user documentation.	Implementation	IEEE/EIA Standard 12207.0/ 5.4.3	A
59	Bank does not have procedures related to software user documentation.	Implementation	IEEE Standard 1063/ 4	A
60	Bank does not have process documentation for storage, distribution, and maintenance of user documentation	Implementation	IEEE/EIA Standard 12207.0/ 6.1.1.1	A
61	Procedures related to user documentation to guide documentation process are not prepared by banks.	Implementation	IEEE/EIA Standard 12207.0/ 6.1.1.1	A, C
62	Procedures regarding receiving, recording, and tracking problem reports and modification requests from the users and providing feedback to the users does not exist at Bank A.	Maintenance	IEEE/EIA Standard 12207.0/ 5.5.1.2	A
63	Feasibility study performed for maintenance requests does not contain alternate solutions, classification of maintenance, and identification of ripple effects.	Maintenance	IEEE Standard 1219/ 4.2.2.1	C
64	Although impact of change to current users is considered within feasibility study of modification; preliminary implementation plans are not created by banks.	Maintenance	IEEE Standard 1219/ 4.2.2.2	A, B, C
65	Approval regarding the satisfactory completion of maintenance is not obtained at Bank B and Bank C.	Maintenance	IEEE/EIA Standard 12207.0/ 5.5.2.5	B, C
66	Post-operation review process is not established to assess the impact of the change to the new environment.	Maintenance	ISO/IEC Standard 14764 and IEEE Standard 14764/ 5.5.2.6	A, B, C
67	Bank does not have a formal mechanism to verify that company's practices comply with defined system development process for the projects.	Review	IEEE/EIA Standard 12207.2/ 6.4.2.2	C

No	Problem	Phase	Standard/Section	Bank(s)
68	Procedures related to managerial and technical reviews are not documented at Bank C.	Review	IEEE Standard 1028/ 4.5.1	C
69	Installation plans, maintenance plans, software configuration management plans, and software safety plans are not subject to management reviews.	Review	IEEE Standard 1028/ 4.1	A, B
70	Customer and user representative complaints and software quality assurance plans are not subject to management review at Bank A.	Review	IEEE Standard 1028/ 4.1	A
71	Back-up and recovery plans, contingency plans, disaster plans, procurement and contracting methods, and hardware performance plans are not subject to management review at Bank B.	Review	IEEE Standard 1028/ 4.1	B
72	Technical review process is not formally executed at Bank A and Bank B.	Review	IEEE Standard 1028/ 5.1	A, B
73	Maintenance manual, system build procedures, installation procedures, and release notes are not subject to technical reviews.	Review	IEEE Standard 1028/ 5.1	B, C
74	Software user documentation is not subject to technical review at Bank B.	Review	IEEE Standard 1028/ 5.1	B
75	Software test documentation is not subject to technical review at Bank C.	Review	IEEE Standard 1028/ 5.1	C
76	Software user documentation, maintenance manuals, system build procedures are not subject to internal inspections.	Review	IEEE Standard 1028/ 6.1	A, B, C
77	Release notes and installation procedures are not subject to internal inspections.	Review	IEEE Standard 1028/ 6.1	A, B
78	Software requirements specification documents are not subject to internal inspections at Bank C.	Review	IEEE Standard 1028/ 6.1	C
79	Software test documentation is not subject to internal inspections at Bank A.	Review	IEEE Standard 1028/ 6.1	A
80	Software products are not subject to walk-through reviews.	Review	IEEE Standard 1028/ 7.1	A, B, C
81	Post-implementation review is not performed by Bank C to compare project planning information to actual project results.	Review	IEEE Standard 1074/ A.5.1.1	C
82	Design verification is not performed by Bank A, Bank B, and Bank C.	Review	IEEE/EIA Standard 12207.2/ 6.4.2	A, B, C
83	Process verification is not performed by Bank A and Bank C.	Review	IEEE/EIA Standard 12207.2/ 6.4.2	A, C
84	Contract verification and requirements verification are not performed by Bank C.	Review	IEEE/EIA Standard 12207.2/ 6.4.2	C

Moreover, below table (Table 8) is a summary of problems according to Waterfall model system development phases.

Table 8: Problems by Phases

Phase	Problems	Questions	Normalized*
Review	18	15	120**
Project management	15	20	75
System development	2	3	67
Implementation	7	11	64
Testing	10	16	63
Feasibility	2	4	50
Coding/Package selection	13	28	46
Design	4	9	44
Analysis	9	21	43
Maintenance	5	24	21

* Problem values are normalized with 100 questions

** Excessive value is due to multiple occurrences of problems for a single question

One another listing that is important related to the results of examination is classification of problems by standards and phases. Below table (Table 9) summarizes identified problems by IEEE standards. These results are consistent with the number of questions and the portion of the standard covering system development life cycle. Because, standards that have highest problems cover highest portion of system development phases and system development life cycle. This result can be verified using Appendix A.

Table 9: Problems by Standards and Phases

Phase	Problems	Standard/ Section
Project management	15	
	7	IEEE 1058/ 4
	1	IEEE 1074/ A.1.3
	2	IEEE 1074/ A.1.2
	5	IEEE 1540/ 5.1
System development	2	
	2	Literature review
Feasibility	2	
	1	IEEE 1062/ 5.1
	1	IEEE 1074/ A.2.1
Analysis	9	
	1	IEEE 1074/ A.1.1
	1	IEEE 1074/ A.3.1
	1	IEEE/EIA 12207.0/ 5.1

Phase	Problems	Standard/ Section
	1	IEEE 1233/ 5.3
	1	IEEE 1233/ 6.3
	3	IEEE 830/ 4
	1	IEEE 1061/ 3
Design	4	
	1	IEEE 730/ 4
	1	Waterfall model/ design
	2	IEEE/EIA 12207.0/ 5.3
Coding/Package selection	13	
	2	IEEE 1074/ A.3.3
	1	IEEE 828/ 1.2
	3	IEEE 828/ 3.2
	1	IEEE 1074/ A.1
	1	IEEE 828/ 3.3
	1	IEEE 1062/ 5.2
	3	IEEE/EIA 12207.0/ 5.3
	1	IEEE/EIA 12207.0/ 5.3 and IEEE/EIA 12207.2/ 5.3
Testing	10	
	1	IEEE 1074/ A.1
	1	IEEE/EIA 12207.0/ 5.3 and IEEE/EIA 12207.2/ 5.3
	1	IEEE 1074/ A.5
	2	IEEE 1074/ A.4
	1	IEEE 829/ 4.1
	1	IEEE 829/ 5.1
	1	IEEE 829/ 6
	1	IEEE 829/ 11.2
	1	IEEE 1062/ 5.8
Implementation	7	
	1	IEEE 1074/ A.4
	3	IEEE/EIA 12207.0/ 5.4
	1	IEEE 1063/ 4
	2	IEEE/EIA 12207.0/ 6.1
Maintenance	5	
	2	IEEE/EIA 12207.0/ 5.5
	2	IEEE 1219/ 4.2
	1	ISO/IEC 14764 and IEEE 14764/ 5.5
Review	18	
	4	IEEE/EIA 12207.2/ 6.4
	4	IEEE 1028/ 4
	4	IEEE 1028/ 5
	4	IEEE 1028/ 6
	1	IEEE 1028/ 7
	1	IEEE 1074/ A.5

Problems that have been identified are presented in below table (Table 10) according to individual problems of the banks by system development phases. Table summarizes that industrial process compliance does not show great differences at three banks.

Table 10: Individual Problems by Phases

Phase	Bank A	Bank B	Bank C
Project management	8	7	10
System development	1	0	1
Feasibility	1	1	1
Analysis	3	2	5
Design	4	0	3
Coding/Package selection	9	8	11
Testing	5	5	5
Implementation	6	2	2
Maintenance	3	3	4
Review	9	9	11
Total	49	37	53

Finally it is proper to provide individual facts about three banks with presentation of their problems by standards and phases. Table 11, Table 12 and Table 13 lists problems of three banks by standards and sections.

Table 11: Problems of Bank A

Phase	Problems	Standard/ Section
Project management	8	
	4	IEEE 1058/ 4
	4	IEEE 1540/ 5.1
System development	1	
	1	Literature review
Feasibility	1	
	1	IEEE 1062/ 5.1
Analysis	3	
	2	IEEE 830/ 4
	1	IEEE 1061/ 3
Design	4	
	1	IEEE 730/ 4
	1	Waterfall model/ design
	2	IEEE/EIA 12207.0/ 5.3

Phase	Problems	Standard/ Section
Coding/Package selection	9	
	1	IEEE 1074/ A.3.3
	1	IEEE 828/ 1.2
	4	IEEE 828/ 3
	1	IEEE 1074/ A.1
	1	IEEE 1062/ 5.2
	1	IEEE/EIA 12207.0/ 5.3
Testing	5	
	1	IEEE 1074/ A.1
	1	IEEE 1074/ A.5
	1	IEEE 1074/ A.4
	1	IEEE 829/ 5.1
	1	IEEE 829/ 11.2
Implementation	6	
	1	IEEE 1074/ A.4
	2	IEEE/EIA 12207.0/ 5.4
	1	IEEE 1063/ 4
	2	IEEE/EIA 12207.0/ 6.1
Maintenance	3	
	1	IEEE/EIA 12207.0/ 5.5
	1	IEEE 1219/ 4.2
	1	ISO/IEC 14764 and IEEE 14764/ 5.5
Review	9	
	2	IEEE/EIA 12207.2/ 6.4
	2	IEEE 1028/ 4.1
	1	IEEE 1028/ 5.1
	3	IEEE 1028/ 6.1
	1	IEEE 1028/ 7.1

Table 12: Problems of Bank B

Phase	Problems	Standard/Section
Project management	7	
	3	IEEE 1058/ 4
	2	IEEE 1074/ A.1
	2	IEEE 1540/ 5.1
System development	0	
Feasibility	1	
	1	IEEE 1074/ A.2
Analysis	2	
	1	IEEE 830/ 4.1
	1	IEEE 1233/ 5.1
Design	0	
Coding/Package selection	8	
	1	IEEE 1074/ A.3.3
	2	IEEE 828/ 3
	1	IEEE 1074/ A.1

Phase	Problems	Standard/Section
	4	IEEE/EIA 12207.0/ 5.3
Testing	5	
	1	IEEE 1074/ A.1
	1	IEEE/EIA 12207.0/ 5.3 and IEEE/EIA 12207.2/ 5.3
	1	IEEE 829/ 4.1
	1	IEEE 829/ 5.1
	1	IEEE 829/ 6
Implementation	2	
	1	IEEE 1074/ A.4
	1	IEEE/EIA 12207.0/ 5.4
Maintenance	3	
	1	IEEE 1219/ 4.2
	1	IEEE/EIA 12207.0/ 5.5
	1	ISO/IEC 14764 and IEEE 14764/ 5.5
Review	10	
	2	IEEE/EIA 12207.2/ 6.4
	2	IEEE 1028/ 4.1
	3	IEEE 1028/ 5.1
	2	IEEE 1028/ 6.1
	1	IEEE 1028/ 7.1

Table 13: Problems of Bank C

Phase	Problems	Standard/ Section
Project management	10	
	7	IEEE 1058/ 4
	2	IEEE 1074/ A.1
	1	IEEE 1540/ 5.1
System development	1	
	1	Literature review
Feasibility	1	
	1	IEEE 1062/ 5.1
Analysis	5	
	1	IEEE 1074/ A.1
	1	IEEE/EIA 12207.0/ 5.1
	1	IEEE 1233/ 6.3
	1	IEEE 830/ 4.5
	1	IEEE 1074/ A.3
Design	3	
	1	IEEE 730/ 4

Phase	Problems	Standard/ Section
	2	IEEE/EIA 12207.0/ 5.3
Coding/Package selection	11	
	1	IEEE 1074/ A.3.3
	1	IEEE 828/ 1.2
	3	IEEE 828/ 3
	1	IEEE 1074/ A.1
	1	IEEE 1062/ 5.2
	3	IEEE/EIA 12207.0/ 5.3
	1	IEEE/EIA 12207.0/ 5.3 and IEEE/EIA 12207.2/ 5.3
Testing	5	
	2	IEEE 1074/ A.4
	1	IEEE 829/ 5.1
	1	IEEE 829/ 11.2
	1	IEEE 1062/ 5.8
Implementation	2	
	1	IEEE/EIA 12207.0/ 5.4
	1	IEEE/EIA 12207.0/ 6.1
Maintenance	4	
	2	IEEE 1219/ 4.2
	1	IEEE/EIA 12207.0/ 5.5
	1	ISO/IEC 14764 and IEEE 14764/ 5.5
Review	11	
	4	IEEE/EIA 12207.2/ 6.4
	1	IEEE 1028/ 4.5
	2	IEEE 1028/ 5.1
	2	IEEE 1028/ 6.1
	1	IEEE 1028/ 7.1
	1	IEEE 1074/ A.5.1

CHAPTER SIX

CONCLUSION

As a conclusion of the study, finding common system development process problems of major Turkish banks is realized by using internationally accepted system development and software engineering standards.

As it has been discussed in detail in the previous chapter, list of problems have shown that three major Turkish banks have process compliance problems to standards in each phase of system development.

This issue can be related with many factors such as:

- BRSA has started information systems audit regulations in 2006 and banks are now in the initiation phase of projects in order to reach to certain software process maturity levels using CoBit and CMMI frameworks. Moreover, process maturity is a new concept for banks which they are trying to adopt by changing or restructuring existing processes.
- Number of individual problems listed is very close to each other which indicate that banks are all in the initiation phase for process improvements which is also verified by banking professionals at the interviews.
- Highest number of problems is identified for standards that cover the largest portion of system development life cycle

which is extremely normal as question numbers have increased due to coverage of standards.

- When problems by phases are observed, it is proper to come up with the result that most problematic phases are review, project management, system development, implementation, and testing which is affiliated with the density of questions and availability of standards for these phases.

On the other hand, study has proven that three banks have common problems in the following areas:

- All of the managerial plans suggested by the standards such as estimation, staff, and training plans are not prepared by banks.
- Banks are not preparing project control plans that should include metrics, reporting mechanisms, and control procedures.
- An overall, detailed release management plan including software release management objectives, including release frequency is not prepared by three banks; banks choose to have specific release delivery dates.
- Access to software libraries are not governed with formally documented and accepted procedures at all banks.
- Documentation of development is not performed at three banks which allow dissemination and storage of tacit knowledge and development experience of technical staff.
- Test design specification documents are not prepared to specify the test approach and methods to be used and pass/fail

criteria for the software features at three banks which allow a design approach to software and system testing.

- Preliminary implementation plans are not created for modifications to ensure minimal impact of changes to existing organization.
- Post-operation review process is not established to assess the impact of the modification to existing environment at all banks which allows earlier identification of problems.
- In terms of review, software user documentation, maintenance manuals, system build procedures are not subject to internal inspections.
- Software products are not subject to walk-through reviews to ensure knowledge sharing and collaboration between technical staff.
- Design verification is not performed to verify that design is compliant with defined system requirements and design is traceable from system requirements.

Although study does not include all of the private banks in Turkey, we assume that results that have been found for three major Turkish banks provide a clue for process compliance condition of other banks in the industry. Moreover, it is worth to mention that, taking found problems into consideration will help banks to improve their existing system development processes and reach to higher project success rates. It is also obvious that further researches covering other banks will be appropriate and important to enhance industrial information base and industrial facts.

As a progress to limitations encountered during preparation of the study, major limitation that has to be solved during preparing such a thesis is confidentiality requirements of the Turkish banks. As a solution to this problem confidentiality agreement has been signed with three banks. But, it should have been a more detailed study if it has been possible to gather banks' process documentation in the initiation phase of the thesis. So, banks' confidentiality requirements left some information out of the thesis due to the nature of organizations' characteristics in terms of corporate governance and transparency.

On the other hand, during selection of banks and preparation of introduction part, it has been a major challenge to find out facts and figures related to the individual IT expenditures of the banks. Regulatory bodies such as BRSA, the Banks Association of Turkey retrieve such data by accounts from the banks. However, indicators such as IT expenditures, IT staff, and project success rates are not included within the publications and reports published by these organizations. Moreover, banks keep such kind of historical records but are hesitant to share such information due to strict organizational confidentiality within the industry.

Finally, as targeted audience, this study aims to provide significant facts about industrial process status information to IT staff of Turkish banks, independent auditing companies, all the individuals interested in process improvement and analysis using an alternate approach rather than well-known frameworks such as CobiT and CMMI. It is worth to mention that, this type of study can be extended to several special IT governance topics such as change management, supplier relationship management for IT

departments, software configuration management and so on. Because, literature review has shown that there are enough number of standards in expected level of details.

REFERENCES

- Agile Alliance (2001). *Agile manifesto*. Retrieved: August 25, 2007, from <http://www.agilemanifesto.org>
- ANSI. (2007). *ISO programs*. Retrieved November 3, 2007, from http://www.ansi.org/standards_activities/iso_programs/overview.aspx?menuid=3
- BRSA. (2006). *BRSA yearly report*. Retrieved November 10, 2007, from <http://www.bddk.org.tr>
- BRSA. (2007a). *BRSA strategic plan 2006- 2008*. Retrieved December 15, 2007, from <http://www.bddk.org.tr>
- BRSA. (2007b). *BRSA monthly bulletin September 2007 period*. Retrieved November 18, 2007, from <http://www.bddk.org.tr>
- Duggan, E. W. & Reichgelt, H. (2006). *Measuring information systems delivery quality*. Hershey, PA: Idea Group Publishing.
- Fairley, R. E. & Willshire, M. J. (2005). Iterative rework: The good, the bad, and the ugly. *IEEE Computer*, 38, 35.
- Fioravanti, F. (2006). *Skills for managing rapidly changing IT projects*. Hershey PA: IRM Press.
- Fruhling, A. & Tyser, K. & Vreede, G. D. (2005). *Experiences with Extreme Programming in telehealth: Developing and implementing a biosecurity health care application*, Proceedings of the 38th Hawaii International Conference on System Sciences, IEEE.
- Gomaa, H. & Kerschberg, L. & Farrukh, A. G. (2000). Domain modeling of software process models. *IEEE*, 51-52.
- Huisman, M. & Iivari, J. (2006). The deployment of systems development methodologies: Perceptual congruence between IS managers and system developers. *Information & Management*, 43, 1.
- IEEE& EIA. (1996). *IEEE/EIA 12207.0 Industry implementation of international standard ISO/IEC 12207:1995, (ISO/IEC 12207) Standard for information technology - Software life cycle processes*. New York, USA: The Institute of Electrical and Electronics Engineers, Inc. (IEEE) & Electronic Industries Alliance (EIA).

- IEEE. (1997). *IEEE standard for software reviews 1028*. New York, USA: The Institute of Electrical and Electronics Engineers, Inc. (IEEE).
- IEEE& EIA. (1997). *IEEE/EIA 12207.2 Industry implementation of international standard ISO/IEC 12207:1995, (ISO/IEC 12207) Standard for information technology - Software life cycle processes- Implementation considerations*. New York, USA: The Institute of Electrical and Electronics Engineers, Inc. (IEEE) & Electronic Industries Alliance (EIA).
- IEEE. (1998a). *IEEE standard for software project management plans 1058*. New York, USA: The Institute of Electrical and Electronics Engineers, Inc. (IEEE).
- IEEE. (1998b). *IEEE recommended practice for software acquisition 1062*. New York, USA: The Institute of Electrical and Electronics Engineers, Inc. (IEEE).
- IEEE. (1998c). *IEEE guide for developing system requirements specifications 1233*. New York, USA: The Institute of Electrical and Electronics Engineers, Inc. (IEEE).
- IEEE. (1998d). *IEEE recommended practice for software requirements specifications 830*. New York, USA: The Institute of Electrical and Electronics Engineers, Inc. (IEEE).
- IEEE. (1998e). *IEEE standard for a software quality metrics methodology 1061*. New York, USA: The Institute of Electrical and Electronics Engineers, Inc. (IEEE).
- IEEE. (1998f). *IEEE recommended practice for software design descriptions 1016*. New York, USA: The Institute of Electrical and Electronics Engineers, Inc. (IEEE).
- IEEE. (1998g). *IEEE standard for software test documentation 829*. New York, USA: The Institute of Electrical and Electronics Engineers, Inc. (IEEE).
- IEEE. (1998h). *IEEE standard for software maintenance 1219*. New York, USA: The Institute of Electrical and Electronics Engineers, Inc. (IEEE).
- IEEE. (2001a). *IEEE standard for software life cycle processes-Risk management 1540*. New York, USA: The Institute of Electrical and Electronics Engineers, Inc. (IEEE).
- IEEE. (2001b). *IEEE standard for software user documentation 1063*. New York, USA: The Institute of Electrical and Electronics Engineers, Inc. (IEEE).

- IEEE. (2002). *IEEE standard for software quality assurance plans 730*. New York, USA: The Institute of Electrical and Electronics Engineers, Inc. (IEEE).
- IEEE. (2005). *IEEE standard for software configuration management plans 828*. New York, USA: The Institute of Electrical and Electronics Engineers, Inc. (IEEE).
- IEEE. (2006a). *IEEE standard for developing a software project life cycle process 1074*. New York, USA: The Institute of Electrical and Electronics Engineers, Inc. (IEEE).
- IEEE. (2007a). *Benefits of standards*. Retrieved November 1, 2007, from <http://www.ieee.org/web/standards/home/index.html>
- IEEE. (2007b). *About IEEE*. Retrieved November 1, 2007, from <http://www.ieee.org/web/aboutus/home/index.html>
- IEEE. (2007c). *IEEE Region*. Retrieved August 13, 2007, from <http://www.ewh.ieee.org/reg/8/cms/>
- IEEE. (2007d). *IEEE software standards subscription*. Retrieved August 17, 2007, from <http://ieeexplore.ieee.org/ISOL/package.jsp?punumber=28&type=P>
- Interbank Card Center. (2008). *About BKM*. Retrieved February 6, 2008, from <http://www.bkm.com.tr/en/bkm.html>
- ISO& IEC& IEEE. (2006b). *Software engineering - Software life cycle processes - Maintenance 14764*. New York, USA: International Organization for Standardization (ISO) & International Electrotechnical Commission (IEC) & the Institute of Electrical and Electronics Engineers, Inc. (IEEE).
- ISO. (2007a). *JTC 1/SC 7 software and systems engineering*. Retrieved November 5, 2007, from http://www.iso.org/iso/standards_development/technical_committees/list_of_iso_technical_committees/iso_technical_committee.htm?commid=45086
- ISO. (2007b). *About ISO*. Retrieved November 5, 2007, from <http://www.iso.org/iso/about.htm>
- ISO. (2007c). *Participation in technical committees*. Retrieved August 12, 2007, from http://www.iso.org/iso/about/iso_members/iso_member_participation_tc.htm?member_id=2168
- ISO. (2007d). *JTC 1/SC 7: Software and systems engineering published standards*. Retrieved August 12, 2007, from

http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_tc_browse.htm?commid=45086&published=true

- Kalaycı, O. (1995). *Software process assessment and application in the Turkish software industry*. Istanbul: Boğaziçi University.
- Khalifa, M. & Verner, J. M. (2000). Domain modeling of software process models, *IEEE Transactions on Engineering Management*, 47, 360-361.
- McConnell, S. (1996). *Rapid development: Taming wild software schedules*. Redmond, WA: Microsoft Press.
- Moore, J. W. (1999). An integrated collection of software engineering Standards. *IEEE Software*, 16, 51-57.
- Olson, D. L. (2004). *Introduction to information systems project management (2nd Ed.)*. New York: McGraw-Hill/ Irwin.
- Standish Group. (1994). *The Chaos report*. Retrieved 17 August, 2007, from http://www.standishgroup.com/sample_research/chaos_1994_1.php
- Tarhan, A. (1998). *An assessment of software development practices in Turkey*. Istanbul: Boğaziçi University.
- The Banks Association of Turkey. (2008a). *About the association*. Retrieved February 6, 2008, from <http://www.tbb.org.tr/english/v12/aboutbat.htm>
- The Banks Association of Turkey. (2008b). *Statistical reports*. Retrieved February 6, 2008, from <http://www.tbb.org.tr/net/donemsel/default.aspx?dil=TR>
- Tran, V. & Liu, D. (1997). Component-based systems development: Challenges and lessons learned. *IEEE Computer*, 453-454.
- TSI. (2007). *Information services*. Retrieved August 13, 2007, from <http://www.tse.org.tr/Turkish/abone/enformasyon.asp>
- Varlı, A. T. (2007). *Bankacılıkta bilgi sistemleri yönetimi ve denetimi/ Mevzuat çerçevesinde BDDK perspektifi*. Retrieved November 25, 2007, from <http://www.bddk.org.tr> .
- Yamamichi, N. & Ozeki, T. & Yokochi, K. & Tanaka, T. (1996). *The evaluation of new software developing process based on a Spiral modeling*. Global Telecommunications Conference GLOBECOM '96 'Communications: The key to global prosperity, IEEE, 3, 18-22.

APPENDICES

APPENDIX A

IEEE STANDARDS USED FOR THE QUESTIONS

Table 14: IEEE Standards Used for the Questions

Standard Number	Description	Reason for usage
730-2002	IEEE Standard for Software Quality Assurance Plans- Revision of 730-1998	Standard refers to the design phase of SD process
828-2005	IEEE Standard for Software Configuration Management Plans- Revision of 828-1998	Standard refers to Coding/Package selection phase of SD process
829-1998	IEEE standard for software test documentation	Standard refers to Testing phase of SD process
830-1998	IEEE recommended practice for software requirements specifications	Standard refers to Analysis&Requirements definition phase of SD process

1016-1998	IEEE recommended practice for software design descriptions	Standard refers to the design phase of SD process
1028-1997	IEEE Standard for Software Reviews	Standard refers to review phase of SD process
1058-1998	IEEE standard for software project management plans	This standard refers to the Project Management phase of SD process
1058.1-1987	IEEE standard for software project management plans	This standard refers to the Project Management phase of SD process
1061-1998	IEEE standard for a software quality metrics methodology	This standard refers to Analysis&Requirements Definition and Review phases of SD process
1062-1998	IEEE recommended practice for software acquisition	Standard refers to Feasibility, Coding/Package Selection, Testing and Implementation phases of SD process
1063-2001	IEEE standard for software user documentation-Reaffirmed 2007	Standard refers to Implementation phase of SD process

1074-2006	IEEE Standard for Developing a Software Project Life Cycle Process-Revision of 1074-1997	Standard refers to all defined phases of SD process
1233-1998	IEEE guide for developing system requirements specifications	Standard refers to Analysis&Requirements definition phase of SD process
12207.0-1996	IEEE/EIA 12207.0-1996 IEEE/EIA Standard Industry Implementation of International Standard ISO/IEC 12207: 1995 (ISO/IEC 12207) Standard for Information Technology Software Life Cycle Processes	This standard refers to all phases of SDLC except Review phase

12207.1-1997	Industry implementation of International Standard ISO/IEC 12207: 1995. (ISO/IEC 12207) standard for information technology - software life cycle processes - life cycle data	This standard refers to Design phase of the SDLC
12207.2-1997	Industry implementation of International Standard ISO/IEC 12207: 1995. (ISO/IEC 12207 standard for information technology - software life cycle processes - implementation considerations	This standard refers to Analysis&Requirements Definition, Design, Testing, Maintenance, Review phases of SDLC
ISO/IEC 14764 IEEE Std 14764-2006	International Standard - ISO/IEC 14764 IEEE Std 14764-2006	This standard refers to the Maintenance phase of SD process.

APPENDIX B

IEEE STANDARDS NOT USED FOR THE QUESTIONS

Table 15: IEEE Standards not used for the Questions

Standard Number	Description	Reason for misuse
610.12-1990	IEEE standard glossary of software engineering terminology	Standard does not refer to a phase of SD process
982.1-2005	IEEE Std 982.1 - 2005 IEEE Standard Dictionary of Measures of the Software Aspects of Dependability- Revision of 982.1-1988	Measures provided with the standard are already assessed in the process by with IEEE standards 12207.0-1996, 1074, 1012.
1008-1987	IEEE standard for software unit testing	Umbrella standard IEEE/EIA 12207.0 1996 covers this process
1012-2004	IEEE Std 1012 - 2004 IEEE Standard for Software Verification and Validation- Revision of 1012-1998	Verification process is assessed with IEEE/EIA 12207.2 1997

1044-1993	IEEE standard classification for software anomalies	This standard refers to a specific point in software engineering rather than the system development process
1045-1992	IEEE standard for software productivity metrics	This standard is substituted with IEEE Standards 1074, 730, 1061
1175.1-2002	IEEE Guide for CASE Tool Interconnections-Classification and Description-Reaffirmed 2007	This standard is a guide to 1175.2 and 1175.3 and can only be used where these 2 standards are used
1175.2-2006	IEEE Recommended Practice for CASE Tool Interconnection Characterization of Interconnections	This standard does not refer to a phase of SD process
1175.3-2004	IEEE Standard for CASE Tool Interconnections-Reference Model for Specifying Software Behavior	This standard does not refer to a phase of SD process
1228-1994	IEEE standard for software safety plans	This standard does not refer to a phase of SD process. It discusses a special issue for safety-critical softwares.

1320.1-1998	IEEE standard for functional modeling language - syntax and semantics for IDEF0	This standard does not refer to a phase of SDLC. It discusses a special issue namely functional modeling language.
1320.2-1998	IEEE standard for conceptual modeling language syntax and semantics for IDEF1X97 (IDEFobject)	This standard does not refer to a phase of SD process. It discusses a special issue namely conceptual modeling language.
1362-1998	IEEE guide for information technology - system definition - Concept of Operations (ConOps) document	This standard provides a document outline for a process already assessed at 12207.0
1420.1-1995	IEEE standard for information technology - software reuse - data model for reuse library interoperability: Basic Interoperability Data Model (BIDM)	This standard provides a specific data model for software interoperability and does not refer to a phase of SD process.

1420.1a-1996	IEEE Supplement to Standard for Information Technology-- Software Reuse-- Data Model for Reuse Library Interoperability: Asset Certification Framework	This standard provides a specific data model for software interoperability and does not refer to a phase of SD process.
1420.1b-1999	IEEE trial-use supplement to IEEE standard for information technology - software reuse - data model for reuse library interoperability: intellectual property rights framework	This standard provides a specific data model for software interoperability and does not refer to a phase of SD process.
1462-1998	Information technology - guideline for the evaluation and selection of CASE tools	This standard provides evaluation methods for CASE tools and does not refer to a phase of SD process.

1465-1998	IEEE Standard Adoption of International Standard ISO/IEC 12119: 1994(E) Information Technology - Software packages - Quality requirements and testing	Testing Package Software process is already covered with the standard 1062
1490-2003	IEEE Guide Adoption of PMI Standard A Guide to the Project Management Body of Knowledge	Project Management process is assessed with IEEE standards 1058, 1074, 1540. This standard also refers to IEEE Standards 1058, 1074.
1517-1999	IEEE Standard for Information Technology - Software Life Cycle Processes - Reuse Processes	This standard refers to a specific subject in SD namely "Reuse Processes" which is excluded in the scope of the thesis

14143.1-2000	Implementation note for IEEE adoption of ISO/IEC 14143-1:1998. Information technology - software measurement - functional size measurement. Part 1: definition of concepts	This standard deals with a special topic in Software Engineering namely software functional size measurement and does not relate to SD process.
15288-2004	Adoption of ISO/IEC 15288:2002 Systems Engineering - System Life Cycle Processes	This standard can be substituted with IEEE Standard 12207.0 and relational standard 1233 has been used to assess SD process
ISO IEC 16085-2006	Std. 16085-2006	Process mentioned in this standard is already assessed with IEEE Standard 1540.
ISO/IEC 23026; IEEE Std 2001-2002, First edition	Software Engineering - Recommended Practice for the Internet - Web Site Engineering, Web Site Management, and Web Site Life Cycle	This standard does not refer to a phase of SD process. Standard deals with a special software product namely websites

ISO/IEC 26702 IEEE Std 1220- 2005	Systems engineering - Application and management of the systems engineering process	This standard is for conjunction with IEEE 15288 which has already been substituted with 12207.0 and relational standard of 1233 of 15288.
ISO/IEC 42010 IEEE Std 1471- 2000	Systems and software engineering - Recommended practice for architectural description of software- intensive systems	This standard deals with a special topic in Software Engineering namely architectural description and does not relate to SD process.

APPENDIX C

SYSTEM DEVELOPMENT PROCESS QUESTIONS

Project management in general

1. Question: What are the characteristics of the projects being managed in terms of scale?

Small

Medium

Large

Other

Notes

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2. Question: What are the characteristics of the projects being managed in terms of budget and requirements (fast-changing, concrete)?

Fast changing

Concrete

Other

Notes

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3. Question: Are software project management plans created for the software projects?

For example:

Estimation

Staffing	
Staff training	
Work activities	
Resource allocation	
Budget allocation	
Requirements control plan	
Schedule control plan	
Budget control plan	
Quality control plan	
Reporting plan	
Risk management plan	
Closeout plan	
Notes	
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Related literature: IEEE standard 1058	

4. Question: How is the project management plan maintained through the life cycle of the project?

Notes	
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Related literature: IEEE standard 1058	

5. Question: Is a project control plan created? Which of the following are specified within the plan?

- Metrics

- Reporting mechanisms.....
- Control procedures (necessary to measure, report, and control the product requirements, the project schedule, budget, and resources, and the quality of work processes and work products)
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Notes

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Related literature: IEEE standard 1058

6. Question: Is the progress of the project reviewed and measured in terms of estimated and actual plans?

Notes

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Related literature: IEEE standard 1074

7. Question: Is there a risk management plan within the software project plan for identifying, analyzing, and prioritizing project risk factors?

Notes

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Related literature: IEEE standard 1058

8. Question: Is there technical process plan created in the software project plan?

Which of the following are included in the plan?

- Specification of development process model

- Technical methods, tools and techniques
- Project infrastructure plans.....
- Product acceptance plan.....

Notes

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Related literature: IEEE standard 1058

9. Question: Is subcontractor management plan created in the software project plan for selecting and managing any subcontractors that may contribute work products to the software project?

Notes

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Related literature: IEEE standard 1058

10. Question: Are criterion for selecting subcontractors specified in the subcontractor management plan?

Notes

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Related literature: IEEE standard 1058

11. Question: Are documentation and training plans created for system development projects?

Notes

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Related literature: IEEE Standard 1074

12. Question: Are project records collected and retained from all activity groups at the close-out?

Notes

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Related literature: IEEE standard 1074

13. Question: Has the company defined risk management policies/procedures for system development projects?

Notes

The company has a risk management policy/procedure that covers

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Related literature: IEEE standard 1540

14. Question: Which aspects of the risk management process are created and documented?

A description of the risk management process to be implemented is documented and promulgated.....

The description of the procedures that implement the risk management process includes

- The frequency at which risks are to be reanalyzed and monitored
- The type of risk analysis required (quantitative and/or qualitative)

- The scales to be used to estimate risk likelihood and consequences and their descriptive and measurement uncertainty
- The types of risk thresholds to be used
- The types of measures used to track and monitor the state of the risks
- How risks are to be prioritized for treatment
- Which stakeholder(s) perspectives the risk management process supports
- The risk categories to be considered

Notes

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Related literature: IEEE standard 1540

15. Question: Does the company define risk thresholds for the projects? For what aspects thresholds are set by the company?

Notes

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Related literature: IEEE standard 1540

16. Question: Does the company create risk profile for the projects?

Which of the following are included in the project risk profile?

- The risk management context
- A chronological record of each risk's state including their likelihoods, consequences, and risk thresholds

- The priority ordering of each risk based on criteria supplied by the stakeholders
- The risk action requests for risks along with the status of their treatment
- The profile should contain a detailed description of each risk, its causes, the estimation scales used, the risk related measures used to evaluate status, contingency plans, and other risk-related information captured in the risk state

Notes

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Related literature: IEEE standard 1540

17. Question: At which frequency project's risk profile or relevant risk profile (e.g., a single or combination of risks) communicated to stakeholders?

Notes

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Related literature: IEEE standard 1540

18. Question: Does the company perform risk analysis throughout the system development life cycle to identify, estimate and evaluate risks? How are the risks evaluated at the end? What are the evaluation parameters?

Notes

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Related literature: IEEE standard 1540

19. Question: Does the company monitor risks for changes in their state using measures? Is the monitoring recorded in the project risk profile? Who is responsible of risk monitoring? Is reporting performed after monitoring process?

Notes

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Related literature: IEEE standard 1540

20. Question: How does the company evaluate its risk management process? Who performs the evaluation of risk management process?

Notes

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Related literature: IEEE standard 1540

System development in general

This section of question list intends to gather general information about the system development approach of the company and is not affiliated with system development standards.

21. Question: Is there a system development process management framework used by the company? (ITIL, CoBIT, CMM)

Notes

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Related literature: Literature review

22. Question: Is there a system development methodology used in the organization?

Notes

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Related literature: Literature review

23. Question: Has the company tailored the system development methodology?

Notes

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Related literature: Literature review

Feasibility

24. Question: Does the company have a software acquisition strategy for acquiring off-the-shelf products?

Notes

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Related literature: IEEE Standard 1062

25. Question: Is feasibility study conducted at the beginning of the system development project? Who is the responsible unit of the feasibility study?

Notes

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Related literature: IEEE standard 1074

26. Question: What are the dimensions of feasibility study? What are the methods of feasibility study? How does the company make the go decision?

- Time.....
- Operational feasibility
- Cost
- User....

Notes

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Related literature: IEEE standard 1074

27. Question: Who approves the result of feasibility study?

Business sponsor.....

Project manager.....

Other

Notes

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Related literature: IEEE standard 1074

Analysis and Requirements definition

28. Question: How does the company identify requirements?

- Only customers.....
- Customer and analysts.....
- Analyst and customer intermediaries.....
- Initiating documents.....
- Analytical exercises.....
- Workshops.....

Notes

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Related literature: IEEE standard 1233

29. Question: Are business sponsors and IT project leads involved in defining business requirements?

Notes

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Related literature: IEEE standard 830

30. Question: Does the company select a software life cycle model appropriate to the scope, magnitude, and complexity of the project?

Notes

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Related literature: IEEE/EIA 12207.2- 1997

31. Question: Are project metrics created for the project with respect to the project requirements, project management plan?

Notes

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Related literature: IEEE standard 1074

32. Question: How does the company approve the analyzed requirements if software requirements analysis is performed by a supplier?
Who approves the analysis?

Notes

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Related literature: IEEE/EIA 12207.0- 1996

33. Question: Are software requirements specification (SRS) documents prepared?

Which of the following are included in SRS documents?

- Functionality.....
- External interfaces.....
- Performance.....
- Attributes.....
- Design constraints.....

Notes

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Related literature: IEEE standard 830

34. Question: Does the company get customer feedbacks during preparation of system requirement specifications to update requirements and customer's problems? Who follows up the requirements that are triggered by the customers?

Notes

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Related literature: IEEE standard 1233

35. Question: Is the technical community included in the requirements specification phase? What is the gain that technical community brings out to the phase?

Notes

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Related literature: IEEE standard 1233

36. Question: Are customer requirements classified?

- Identification.....
- Priority.....
- Criticality.....
- Feasibility.....
- Risk.....
- Source.....
- Type.....

Notes

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Related literature: IEEE standard 1233

37. Question: Does the company validate requirements to be designed from the set of requirements that customers demand? If yes please specify how?

Notes

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Related literature: IEEE standard 1233

38. Question: How are the changes occurring during the project reflected to Software requirements specification (SRS) documents? Is there a formal change process for changing requirements which allows retaining up-to-date SRS documents?

Notes

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Related literature: IEEE standard 830

39. Question: Is prototyping used to create more stable requirements during the requirements definition phase?

Notes

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Related literature: IEEE standard 830

40. Question: How does the company ensure that SRS documents exclude design requirements?

Notes

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Related literature: IEEE standard 830

41. Question: How does the company ensure that SRS documents exclude project requirements such as cost, delivery schedules?

Notes

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Related literature: IEEE standard 830

42. Question: How is the SRS document organized?

Notes

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Related literature: IEEE standard 830

43. Question: Are system functions analyzed after the feasibility study? Is functional description of the system drawn from the system functions?

Notes

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Related literature: IEEE standard 1074

44. Question: Is functional description of the system transformed into the system architecture using the methodology, standards, and tools that are established by the organization?

Notes

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Related literature: IEEE standard 1074

45. Question: Are the system functions that are documented in the Functional Description of the System divided according to the System Architecture in order to form software requirements, human and hardware requirements (if applicable), and the System Interface Requirements? According to what system requirements are grouped by the company?

Notes

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Related literature: IEEE standard 1074

46. Question: Does the software requirements specifications work resulting in SRS document contain user interface requirements?

Notes

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Related literature: IEEE standard 1074

47. Question: Is software requirements specification document subject to approval of business units to agree on defined system requirements?

Notes

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Related literature: IEEE standard 1074

48. Question: Are quality requirements of a system established at the project outset?

Notes

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Related literature: IEEE standard 1061

Design

49. Question: Is software quality assurance plan produced after the definition of system requirements? (Obtain the software QA plan and observe)

Which of the following are included in the software QA plan?

- Purpose
- Reference documents
- Management (IEEE Std 1058TM-1998)
- Documentation (Minimum documentation requirements

IEEE/EIA 12207.1-1997)

- Development process plan
- Software development standards description.....
- Software engineering methods/procedures/tools description.....
- Software project management plan (IEEE Standard 1058TM-1998 [B13])

- Maintenance plan (IEEE Std 1219TM -1998 [B15])
.....
- Software safety plans (IEEE Std 1228 TM -1994 [B16])
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- Software integration plan
- Standards, practices, conventions, and metrics
 - Documentation standards
 - Design standards
 - Coding standards
 - Commentary standards
 - Testing standards and practices
 - Selected software quality assurance product and process metrics.....
- Software reviews(IEEE Std 1028 TM -1997)
 - Define the software reviews to be conducted. They may include managerial reviews, acquirer and supplier reviews
 - Reviews, technical reviews, inspections, walk-through, and audits.....
 - List the schedule for software reviews as they relate to the software project's schedule.....
 - State how the software reviews shall be accomplished.....
 - State what further actions shall be required and how they shall be implemented and verified.....

Minimum requirements

- Software specifications review
 - Architecture design review.....
 - Detailed design review.....
 - Verification and validation plan review.....
 - Functional audit.....
 - Physical audit.....
 - In-process audits
 - Managerial reviews.....
 - Software configuration management plan review.....
 - Post implementation review.....
- Test
 - This section shall identify all the tests not included in the software verification and validation plan for the software covered by the SQAP and shall state the methods to be used. If a separate test plan exists it shall be referenced.....
 - Problem reporting and corrective action
 - This section shall:
 - Describe the practices and procedures to be followed for reporting, tracking, and resolving problems or issues identified in both software

items and the software development and maintenance process.....

- Tools, techniques, and methodologies.....
- Media control.....
- Supplier control.....
 - This section shall state the provisions for assuring that software provided by suppliers meets established requirements. In addition, this section shall state the methods that will be used to assure that the software supplier receives adequate and complete requirements.....
- Records collection, maintenance, and retention
 - This section shall identify the SQA documentation to be retained, shall state the methods and facilities to be used to assemble, file, safeguard, and maintain this documentation, and shall designate the retention period.....
- Training
 - This section shall identify the training activities necessary to meet the needs of the SQAP.....
- Risk management
 - This section shall specify the methods and procedures employed to identify, assess, monitor, and control areas of risk arising during the portion of the software life cycle covered by the SQAP.....

- Glossary.....
- SQAP change procedure and history.....

Notes

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Related literature: IEEE standard 730

50. Question: Who prepares the software design description documents?

Notes

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Related literature: IEEE Standard 1016

51. Question: Who approves the design description documents?

Notes

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Related literature: IEEE Standard 1016

52. Question: How is the software design documents organized?

Notes

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Related literature: IEEE Standard 1016

53. Question: Is architectural design (Hardware, software and network) performed to transform the Software Requirements and the System

Architecture into high-level design concepts? Who performs the architectural design?

Notes

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Related literature: IEEE Standard 1074, IEEE/EIA 12207.0 1996, IEEE/EIA 12207.2 1997

54. Question: Are detailed designs prepared indicating data structure, algorithm, and control information of each software component? (Or for system level, application level, business level)

Notes

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Related literature: IEEE Standard 1074, IEEE/EIA 12207.0 1996

55. Question: Are detailed designs and architectural designs approved by related parties? Who is authorized to approve software design descriptions?

Notes

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Related literature: IEEE Standard 1074, IEEE/EIA 12207.0 1996

56. Question: Is preliminary versions of user documentation prepared by the design staff?

Notes

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Related literature: IEEE/EIA 12207.0 1996

57. Question: Is preliminary versions of test requirements prepared by the design staff?

Notes

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Related literature: IEEE/EIA 12207.0 1996

Coding/Package selection

58. Question: Are development plans created for the development phase of the projects by development department personnel?

Notes

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Related literature: IEEE/EIA 12207.0 1996

59. Question: Are there any coding/commenting standards or procedures that development team has to apply during development? What are the standards in place?

Notes

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Related literature: IEEE standard 1074

60. Question: Is there a review process for the coding to verify compliance to the corporate standards? What are the methods being used for the review process?

Notes

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Related literature: IEEE Standard 1074

61. Question: Are operating documents prepared for the developed system for installing, operating, and supporting the system throughout the life cycle?

Notes

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Related literature: IEEE Standard 1074

62. Question: How is the software to be delivered to test& integration environments packaged? Is it able to modify software after packaging?

Notes

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Related literature: IEEE Standard 1074

63. Question: Does the company produce a software configuration management plan for the whole system development process?

Which of the following are identified in the plan?

- SCM activities to be done?

- How they are to be done?
- Who is responsible for doing specific activities?
- When they are to happen?
- What resources are required?

Notes

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Related literature: IEEE Standard 828

64. Question: Has the company documented a software configuration management procedure? What type of configuration management policy does the company use in practice?

Notes

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Related literature: IEEE Standard 828

65. Question: Are roles and responsibilities documented for the SCM process?

- Technical activities are documented
- Managerial activities are documented clearly

Notes

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Related literature: IEEE Standard 828

66. Question: Does the company create a release management plan that contains overall software release management objectives, including release frequency, release milestones, and release media?

Notes

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Related literature: IEEE Standard 1074

67. Question: Is there a versioning system used for the configuration items? Are the configuration items governed by a system?

Notes

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Related literature: IEEE Standard 828

68. Question: Are there any standards in place related to version naming, marking, documentation labeling for the releases?

Notes

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Related literature: IEEE Standard 828

69. Question: Are there any procedures related to access to the software libraries and retrieval of configuration items from software libraries? What are the access rights for several user groups? Is everyone able to access and retrieve configuration items?

Notes

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Related literature: IEEE Standard 828

70. Question: How is the change process on baseline configuration items managed? How is change identified and documented? How change request is recorded, analyzed and evaluated? How is the change request approved or disapproved? How is the change implemented and released?

Notes

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Related literature: IEEE Standard 828

71. Question: Is there a change log kept by the SCM system regarding the details of changes on configuration items? For how long are the logs kept? Are the logs removed completely after some time?

Notes

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Related literature: IEEE Standard 828

72. Question: If the coding stage of the system development process is outsourced what kind of monitoring process is in place for the contractors?

Notes

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Related literature: IEEE Standard 828

73. Question: How the work of the contractor is reviewed for compliance with the development standards of the enterprise?

Notes

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Related literature: IEEE Standard 828

74. Question: How external code, documentation, and data of the contractor is tested, verified, accepted, and merged with the project software? Is there a review process for the outsourced coding?

Notes

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Related literature: IEEE Standard 828

75. Question: Does the company have a defined software acquisition process for outsourcing the software?

Notes

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Related literature: IEEE Standard 1062

76. Question: Does the company produce Request for Proposal (RFP) document which contains requirements for the software to be purchased and product quality and maintenance plans? Who is responsible of preparing the RFP document?

Notes

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Related literature: IEEE Standard 1062

77. Question: How are the potential suppliers identified and evaluated? Please explain company's supplier evaluation and selection criteria?

Notes

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Related literature: IEEE Standard 1062

78. Question: How is the supplier proposals evaluated?

Notes

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Related literature: IEEE Standard 1062

79. Question: Are acceptance criteria defined at the contracts for selected suppliers?

Notes

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Related literature: IEEE Standard 1062

80. Question: Are supplier and acquirer obligations stated and agreed at the contract?

Notes

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Related literature: IEEE Standard 1062

81. Question: Is each software unit or database developed documented by the related development staff? Who is in charge of coding documentation?

Notes

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Related literature: IEEE/EIA 12207.0 1996

82. Question: Are test procedures and test data created? Who develops test plans and test data?

Notes

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Related literature: IEEE/EIA 12207.0 1996

83. Question: Is developed software subject to unit testing? Who performs the unit testing? Are the test results documented?

Notes

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Related literature: IEEE/EIA 12207.0 1996

84. Question: Is integration testing plan created/documented? Who plans and documents integration tests?

Notes

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Related literature: IEEE/EIA 12207.0 1996, IEEE/EIA 12207.2 1997

85. Question: Is draft user documentation started at the development phase? If no at which phase does the user documentation start?

Notes

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Related literature: IEEE/EIA 12207.0 1996

Testing

86. Question: Has the company established test procedures for the following?

Level of testing

- Unit
- Module
- Component
- Integration
- Acceptance
- Regression
- System

Type of testing

- White box
- Black box
- Destructive
- Noninvasive

Notes

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Related literature: IEEE Standard 1074

87. Question: Are integration plans created for system development projects to combine software components into an overall system?

Notes

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Related literature: IEEE Standard 1074

88. Question: Is integration testing performed? Are the results of integration testing documented?

Notes

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Related literature: IEEE/EIA 12207.0 1996, IEEE/EIA 12207.2 1997

89. Question: Which organizational unit is responsible of checking out the software from the development environment and transferring to target environments?

Notes

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Related literature: IEEE Standard 1074

90. Question: Which organizational unit is responsible of installing the test environment?

Notes

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Related literature: IEEE Standard 1074

91. Question: How does the organization ensure that test environment reflects production environment as much as possible (data, tools)? Which method is used to keep test environment similar to production environment as much as possible?

Notes
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Related literature: IEEE Standard 1074

92. Question: Is operation log of the installation kept to keep track of encountered problems during installation?

Notes
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Related literature: IEEE Standard 1074

93. Question: Are acceptance test plans produced with respect to the analysis documents? Who prepares the acceptance test plan document?

Which of the following are included?

- Scope
- Approach
- Resources
- Schedule for testing activities
- Items to be tested

- Features to be tested
- Testing tasks to be performed
- Personnel responsible for each task.....
- Risks associated with the plan.....

Notes

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Related literature: IEEE Standard 829

94. Question: Who approves acceptance test plans?

- Test Manager
- Project manager
- QA Manager
- Other

Notes

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Related literature: IEEE Standard 829

95. Question: Are test design specification documents prepared?

Who prepares the documents?

Which of the following are included in the document?

- Test design specification identifier
- Features to be tested
- Approach refinements
- Test identification
- Feature pass/fail criteria

Notes

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Related literature: IEEE Standard 829

96. Question: Are test case specification documents prepared? Are test specifications and constraints defined per test cases?

Which of the following are included?

A test case specification shall have the following structure:

- Test case specification identifier
- Test items
- Input specifications....
- Output specifications
- Environmental needs ...
- Special procedural requirements
- Intercase dependencies

Notes

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Related literature: IEEE Standard 829

97. Question: Is test log prepared by the test team during test execution? What actions are taken for the incidents?

Notes

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Related literature: IEEE Standard 829

98. Question: Are test summary reports approved? Who approves?

Notes

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Related literature: IEEE Standard 829-1998

99. Question: What type of software acceptance process is applied to the suppliers (package software purchase)?

Notes

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Related literature: IEEE Standard 1062

100. Question: How does the customer accepts the developed software? What is the practice of the company?

Notes

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Related literature: IEEE standard 1074

101. Question: Are the results of the UAT test approved? Who approves? Are the results of UAT documented?

Notes

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Related literature: IEEE standard 1074

Implementation

102. Question: Which organizational unit is responsible of transferring the software components from test system to production environment? Which conditions are asked to perform the transfer?

Notes

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Related literature: IEEE standard 1074

103. Question: Which organizational unit operates the production environment? How?

Notes

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Related literature: IEEE standard 1074

104. Question: Is the system at the implementation stage monitored for some time in case of errors?

Notes

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Related literature: IEEE standard 1074

105. Question: Has the company established procedures related to the problems encountered at the operation environment during and after implementation?

Notes

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Related literature: IEEE/EIA 12207.0 1996

106. Question: Does the company keep track of the problems encountered at the operation environment during implementation?

Notes

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Related literature: IEEE/EIA 12207.0 1996

107. Question: How does the company ensure that the implemented system is operated according to the user documentation?

Notes

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Related literature: IEEE/EIA 12207.0 1996

108. Question: Does the company provide assistance to system users when necessary? Which organizational unit is responsible for the assistance?

Notes

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Related literature: IEEE/EIA 12207.0 1996

109. Question: How is the supplier performance evaluated for acquired software?

Notes

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Related literature: IEEE Standard 1062

110. Question: Does the company have policies/procedures related to software user documentation?

Notes
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Related literature: IEEE Standard 1063

111. Question: How does the company ensure that user documentation is completed in a timely manner?

Notes
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Related literature: IEEE Standard 1074

112. Question: Does the company have a documentation procedure to be used throughout the system development life cycle for

- Inputs
- Development
- Review
- Modification
- Approval
- Production
- Storage
- Distribution

- Maintenance of the documents

Notes

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Related literature: IEEE/EIA 12207.0 1996

Maintenance

113. Question: Which organizational unit is responsible of the system maintenance?

Notes

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Related literature: IEEE standard 1074

114. Question: Has the company established procedures for receiving, recording, and tracking problem reports and modification requests from the users and providing feedback to the users?

Notes

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Related literature: IEEE/EIA 12207.0 1996

115. Question: Does the company prepare maintenance plans for the system development projects?

Notes

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Related literature: ISO/IEC 14764 2006/ IEEE Standard 14764

116. Question: How is maintenance requests generated in the maintenance process?

Notes

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Related literature: IEEE standard 1219

117. Question: How is maintenance requests generated, classified and prioritized?

Notes

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Related literature: IEEE standard 1219

118. Question: How does the company record/document maintenance requests?

Notes

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Related literature: ISO/IEC 14764, IEEE 14764 2006

119. Question: Is feasibility for maintenance requests prepared?

Which of the following are included?

- Impact of the modification ...
- Alternate solutions ...
- Analysis of conversion requirements ...
- Short-term and long-term costs ...

- Maintenance time ...
- Handling priority ...
- Classification of maintenance ...
- Impact to current users
- Identification of ripple effects ...
- Hardware and software constraints ...
- Level of test and evaluation required ...

Notes

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Related literature: IEEE standard 1219

120. Question: Is a detailed analysis performed to define requirements of the firm to identify elements of the modification (documentation, code, and database) and portions of the modification on these elements?

Notes

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Related literature: IEEE standard 1219

121. Question: Is a preliminary implementation plan created to ensure a minimal impact to current users?

Notes

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Related literature: IEEE standard 1219

122. Question: Does the maintenance unit ask for approval from the business unit for implementation of the selected modification?

Notes

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Related literature: IEEE/EIA 12207.0 1996

123. Question: Are requirements for testing modification elements defined as a test strategy?

Notes

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Related literature: IEEE standard 1219

124. Question: What actions are taken for documentation change requirements resulting from maintenance? Is the update verified?

Notes

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Related literature: IEEE standard 1219

125. Question: Is software (system/user) documentation updated due to the changes in design resulting from the maintenance?

Notes

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Related literature: IEEE standard 1219

126. Question: Is new design document created for the changes in the design resulting from the maintenance?

Notes

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Related literature: IEEE standard 1219

127. Question: Are test cases for regression testing created for the new design resulting from the maintenance? (If maintenance causes a redesign effort)

Notes

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Related literature: IEEE standard 1219

128. Question: Is unit testing performed and documented after coding for the maintenance? Are the results of the unit testing documented?

Notes

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Related literature: IEEE standard 1219

129. Question: Is integration testing performed and documented after coding for the maintenance by integrating the modified software with the system?

Notes

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Related literature: IEEE standard 1219

130. Question: Is acceptance test plan updated with respect to the new design?

Notes

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Related literature: IEEE standard 1219

131. Question: Is system testing performed for the maintenance? Are the results of the system testing documented and reported?

Notes

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Related literature: IEEE standard 1219, IEEE/EIA 12207.2 1997

132. Question: Is acceptance testing performed for the maintenance by the users of the system? Are the results of the acceptance testing reported/retained under SCM?

Notes

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Related literature: IEEE standard 1219

133. Question: Is a backup of the working system taken before installing the maintained new system?

Notes

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Related literature: IEEE standard 1219

134. Question: Is training provided to system users when the modifications result in significant documentation and system changes?

Notes

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Related literature: IEEE standard 1219

135. Question: Does the maintainer obtain approval for the satisfactory completion of the maintenance?

Notes

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Related literature: IEEE/EIA 12207.0 1996

136. Question: Does the maintainer perform a post-operation review to assess the impact of the change to the new environment?

Notes

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Related literature: ISO/IEC 14764

Review

137. Question: How does the company ensure that company's practices comply with defined system development process for the projects?

Notes

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Related literature: IEEE/EIA 12207.2 1997

138. Question: Does the company have a review policy for management and technical reviews?

Notes

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Related literature: IEEE Standard 1028

139. Question: Does the company have technical and management review procedures?

Notes

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Related literature: IEEE Standard 1028

140. Question: Is management review taking place during a system development life cycle?

Notes

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Related literature: IEEE Standard 1028

141. Question: Which of the following software products are subject to management review?

- Anomaly reports ...
- Audit reports ...
- Back-up and recovery plans ...

- Contingency plans ...
- Customer or user representative complaints ...
- Disaster plans ...
- Hardware performance plans ...
- Installation plans ...
- Maintenance plans ...
- Procurement and contracting methods ...
- Progress reports ...
- Risk management plans ...
- Software configuration management plans ...
- Software project management plans ...
- Software quality assurance plans ...
- Software safety plans ...

Notes

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Related literature: IEEE Standard 1028

142. Question: Who is responsible of management review for system development projects?

Notes

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Related literature: IEEE Standard 1028

143. Question: Which software products are subject to technical review?

- Software requirements specification ...
- Software design description ...
- Software test documentation ...
- Software user documentation ...
- Maintenance manual ...
- System build procedures ...
- Installation procedures ...
- Release notes ...

Notes

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Related literature: IEEE Standard 1028

144. Question: Who is responsible of technical reviews for system development projects?

Notes

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Related literature: IEEE Standard 1028

145. Question: Are there any software quality metrics used throughout the system development life cycle to assess software quality requirements and software deficiencies?

Notes

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Related literature: IEEE standard 1061

146. Question: What is the system quality target of the organization for system development?

Notes

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Related literature: IEEE standard 1061

147. Question: How does the organization define software quality?

Notes

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Related literature: IEEE standard 1061

148. Question: Are software products subject to internal inspections?

Which of the following are subject to inspections?

- Software requirements specification ...
- Software design description ...
- Source code
- Software test documentation
- Software user documentation
- Maintenance manual
- System build procedures ...
- Installation procedures ...
- Release notes ...

Notes

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Related literature: IEEE standard 1028

149. Question: Are software products subject to walk-through?

Which of following software products are subject to walk-through?

- Software requirements specification ...
- Software design description ...
- Source code ...
- Software test documentation ...
- Software user documentation
- Maintenance manual ...
- System build procedures ...
- Installation procedures ...
- Release notes ...

Notes

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Related literature: IEEE standard 1028

150. Question: Is post implementation review performed by the organization?

Notes

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Related literature: IEEE Standard 1074

151. Question: Does the company employ a verification process?

Which of the following are verified in the system development process?

Contract verification

- The supplier has the capability to satisfy the requirements.....
- The requirements are consistent and cover user needs.....
- Adequate procedures for handling changes to requirements and escalating problems are stipulated.....
- Procedures and their extent for interface and cooperation among parties are stipulated, including ownership, warranty, copyright and confidentiality.....
- Acceptance criteria and procedures are stipulated in accordance with requirements.....

Process verification

- Project planning requirements are adequate and timely.....
- Processes selected for the projects are adequate, implemented, being executed as planned, and compliant with the contract.....
- The standards, procedures, and environments for the project's processes are adequate.....
- The project is staffed and personnel trained as required by the contract.....

Requirements Verification

- The system requirements are consistent, feasible, and testable.....
- The system requirements have been appropriately allocated to hardware items, software items, and manual operations according to design criteria.....
- The software requirements are consistent, feasible, testable, and accurately reflect system requirements.....

Design verification

- The design is correct and consistent with and traceable to requirements.....
- Selected design can be derived from requirements.....
- The design implements safety, security, and other critical requirements correctly as shown by suitably rigorous methods.....

Other.....

Notes

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Related literature: IEEE/EIA 12207.2 1997