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Software engineering — Guide for the application of ISO/IEC 12207 to project management

Ingénierie du logiciel — Guide pour l'application de l'ISO/CEI 12207 à la gestion de projet

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

Attention is drawn to the possibility that some of the elements of this Technical Report may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

ISO/IEC TR 16326 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 7, *Software engineering*.

Annexes A to E of this Technical Report are for information only.

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Introduction

Software is an integral part of information technology and conventional systems, e.g., transportation, military, medical care and finance. There is a proliferation of standards, procedures, methods, tools and environments for developing and managing software. This proliferation has created difficulties in software project management and engineering, especially in integrating products and services. The software discipline needs to migrate from this proliferation to a common framework for software practitioners to “speak the same language” to create and manage software. ISO/IEC 12207, *Information technology — Software life cycle processes,* provides a common framework.

The ISO/IEC 12207 framework covers the software life cycle from conceptualization of ideas through retirement/closure and consists of processes for acquiring and supplying software products and services. This framework also provides for controlling and improving these processes.

ISO/IEC 12207 provides a comprehensive set of software life cycle processes. An organization, depending on its purpose, can select an appropriate ISO/IEC 12207 subset to fulfil that purpose. ISO/IEC 12207 is designed to be tailored for an individual organization, project or application. It is also designed to be used when software is a standalone entity, or an embedded or integral part of a total system.

This Technical Report provides guidance for the Management Process as introduced by ISO/IEC 12207, subclause 7.1. Most of the guidance is provided based on Project Management Institute’s (PMI’s) *A Guide to the Project Management Body of Knowledge (PMBOK™ Guide)* [11], ISO 10006, *Quality management — Guidelines to quality in project management* [5] and experience of people who have been successful software project managers.

It is not the intent of this Technical Report to suggest any organizational role or responsibility.

It is recognized that identified processes, activities and tasks have an iterative “life” and they may occur in any order or frequency. These processes, activities and tasks must be coordinated with other processes, activities and tasks not emphasized in this Technical Report, e.g., ISO/IEC 12207’s Supporting and Organizational Life Cycle Processes.

This Software Project Management Technical Report is organized as follows:

— Section 1 provides the document’s scope.

— Section 2 identifies the conformance requirements.

— Section 3 identifies the normative references.

— Section 4 provides the definitions used in this Technical Report.

— Section 5 provides the symbols and abbreviations used in this Technical Report.

— Section 6 has guidance on the ISO/IEC 12207 Management Process.

— Annex A maps ISO/IEC 12207 Management Process activities to the ISO/IEC 12207 Primary Processes.

— Annex B maps ISO/IEC 12207 Management Process activities to [11]’s project management knowledge areas.

— Annex C maps ISO/IEC 12207 Management Process activities to [5]’s project management processes.

— Annex D maps ISO/IEC 12207 to [5]’s process levels and to [11]’s project management knowledge area major processes.

— Annex E provides a bibliography of some reference material. This list is not inclusive, nor an endorsement of any reference.

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Software engineering — Guide for the application of ISO/IEC 12207 to project management

1 Scope

This Technical Report supplements International Standard ISO/IEC 12207, *Information technology — Software life cycle processes,* in the area of Management Process (hereafter referred to as "software project management" or SPM. Thus, in this Technical Report, SPM is not a person, but a process). This Technical Report was developed by (see Figure 1):

— Applying the Management Process in ISO/IEC 12207 to SPM.

— Using *A Guide to the Project Management Body of Knowledge™* (*PMBOK™*) [11] to define and describe management knowledge areas applicable to SPM.

— Using ISO 10006, Quality management – Guidelines to quality in project management [5].

This Technical Report provides guidance to people responsible for managing the performance of ISO/IEC 12207 software life cycle Primary Processes: Acquisition, Supply, Development, Operation and Maintenance. The guidance addresses:

— General guidance for SPM regarding ISO/IEC 12207, subclause 7.1, management activities as they are supported in each Primary Process.

— SPM applicability for each Primary Process.

— Key areas applicable across the spectrum of SPM.

— Expanded guidance for software Project Managers (PMs) regarding the management tasks from:

  — [11] — Identifies and describes generally that subset of the PMBOK™ which is generally accepted. Generally accepted means that the knowledge and practices described are applicable to most projects most of the time, and there is widespread consensus about their value and usefulness.

  — [5] — Gives guidance on quality system elements, concepts and practices for which the implementation is important to and has an impact on the practice of project management.

This Technical Report addresses aspects of project management that are either "software specific" or are known to cause problems in software projects in any of the ISO/IEC 12207 Primary Processes. For example, it is well known that software projects are often late and/or over budget, or are unable to meet an acquirer's requirements or expectations. While this is not peculiar to software, there are a number of software specific attributes causing this to happen.

Figure 1 illustrates the relationship of ISO/IEC 12207, [11] and [5] in the development of this Technical Report.

1.1 Audience

This Technical Report is written for those who use or plan to use ISO/IEC 12207 on software projects regardless of project scope, product, methodology, size or complexity. This Technical Report is written primarily to aid software PMs in ensuring management processes conform to ISO/IEC 12207, specifically:

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— Managers responsible for establishing and continuously improving ISO/IEC 12207 software life cycle processes.

— Managers responsible for executing any ISO/IEC 12207 software life cycle process at a project level.

— Organizations or individuals subcontracting an SPM effort.

Consideration is given to people who have:

— Worked on software projects, but not as a software PM.

— Been non-software PMs, but are transitioning to be software PMs.

This Technical Report presents the primary ISO/IEC 12207 life cycle processes from the perspective of a software PM and provides advice (based on experience, lessons learned, etc.) about best practices and recommendations to be applied to management tasks by the practitioners. Lastly, this Technical Report enables engineering, technical and other support staffs to see how their efforts integrate within a total, software life cycle.

1.2 Prerequisites

The prerequisites to use this Technical Report are:

— Availability of and familiarity with ISO/IEC 12207.

— Familiarity with the relevant organizational policies and procedures.

— Knowledge of stakeholder and contract requirements (needs and expectations).

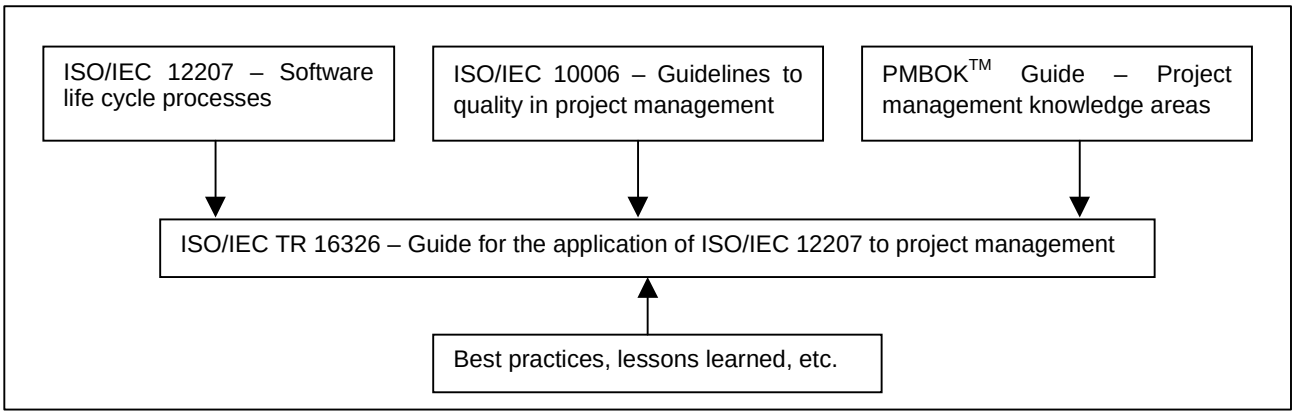

Figure 1 — Use of ISO/IEC 12207, *PMBOK™ Guide* and ISO 10006 to create this Technical Report

2 Conformance

Since this is a Technical Report, there are no conformance requirements.

3 Normative references

Since this is a Technical Report, normative references are not required. See the Bibliography (Annex E) for some informative references.

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4 Terms and definitions

For the purpose of this Technical Report, the definitions given in ISO/IEC 12207, [11] and [5] apply, in that hierarchial order.

5 Symbols and abbreviated terms

The following symbols and abbreviations are used in this Technical Report:

CCB*	Configuration/Change Control Board
ICWG*	Interface Control Working Group
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
PM	Project Manager
SEE	Software Engineering Environment
SPM	Software Project Management
WBS	Work Breakdown Structure

* Depending on the size and complexity of a project, can be a group of people, a single person or a function.

6 Guidance

6.1 Introduction to software project management

A project is a temporary endeavour undertaken to create a unique product or service [11]. As such, a project involves a group of people, resources and events with the following common characteristics:

— The main objectives are to create products, services and results.

— A project has a known beginning and end, i.e., a project is temporary.

— A project is not part of the normal, ongoing operation of most organizations, i.e., it usually has a unique requirement. Some organizations (e.g., Research and Development) exist only to perform projects.

A software project is a project emphasizing software as its product, service or result. So, how does software differ from other project products, services and results? As stated by Watts Humphrey [17]:

— *Software is generally more complex.*

— *Software changes appear relatively easy to make.*

— *Many late-discovered hardware problems are addressed through software changes.*

— *Because of its low reproduction cost, software does not have the natural discipline of release to manufacturing.*

— *Software discipline is not grounded in natural science and it lacks ready techniques for feasibility testing and design modelling.*

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— *Software is often the element integrating an entire system, thus adding to its complexity and creating exposures to late change.*

— *Software is generally most visible, thus most exposed to requirements changes and most subject to user complaint.*

Because software is different from non-software products, services and results, the management of software projects is also different. This is not to say SPM is totally different from the management of non-software projects. The key item is that there are unique areas of SPM and general project management that management must be aware of to achieve project goals, as well as prevent problems.

[11] provides important information about managing projects. ISO/IEC 12207 provides important information about software projects within ISO/IEC 12207, subclause 5.2 (Supply Process) and describes many activities and tasks to be performed. [5] provides information on how to improve the quality of project management. The main purpose of this Technical Report is to highlight how the differences described above impact a software PM, to show how these three documents complement each other and to help PMs manage software projects to a successful conclusion.

Rapidly changing technology in the software discipline is outpacing management and process techniques. This is compounded by the incompleteness of the range of project management tools and techniques available to software engineers as compared to other engineering disciplines.

SPM methodology implementation is determined by many factors, e.g., personnel, organizational and contractual requirements, and project complexity.

A software PM determines the methodology and technology for undertaking a project and should be required to:

— Anticipate and thus prevent or minimize the adverse impact of problems.

— Make timely and firm decisions.

— Resolve problems when they occur.

— Take responsibility for a project's actions, processes, activities, resources, products and results.

As an iterative endeavour, a software PM must consider any systemic impact when undertaking an action, e.g., an action, or failure to act, in an area can affect other areas.

6.2 Management process

This clause examines ISO/IEC 12207's (subclause 7.1) Management Process. ISO/IEC 12207 defines a generic management process (rather than SPM) that may be employed by any party managing its processes. This clause discusses the ISO/IEC 12207 Management Process as it applies to the management of software projects (SPM).

It is recognized that identified processes, activities and tasks may require a reiterative action to accomplish the requirements/goals of a project. For instance, based upon the software life cycle model being used, processes, activities and tasks may be employed at the same time; they may be interdependent; or they may be coordinated in an organized series of Work Breakdown Structure (WBS) dependencies throughout a software project life cycle.

ISO/IEC 12207

7.1 **Management process**. The Management Process contains the generic activities and tasks, which may be employed by any party that has to manage its respective process(es). The manager is responsible for product management, project management, and task management of the applicable process(es), such as the acquisition, supply, development, operation, maintenance, or supporting process.

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ISO/IEC 12207 (subclause 7.1) states “of the applicable process(es)” since a project may not involve all of the Primary Processes. For instance, a project may be only involved with the development or maintenance of a product, rather than product operation.

SPM should define (and the software PM control) the activities needed to ensure products are delivered as specified in a contract, i.e., ensure a software project includes all the work required, and only the work required, to complete the project and product successfully.

6.2.1 Initiation and scope definition

ISO/IEC 12207

7.1.1 Initiation and scope definition. This activity consists of the following tasks:

7.1.1.1 The management process shall be initiated by establishing the requirements of the process to be undertaken.

7.1.1.2 Once the requirements are established, the manager shall establish the feasibility of the process by checking that the resources (personnel, materials, technology and environment) required to execute and manage the process are available, adequate, and appropriate and that the time-scales to completion are achievable.

7.1.1.3 As necessary, and by agreement of all parties concerned, the requirements of the process may be modified at this point to achieve the completion criteria.

Initiation and scope definition is the determination of the feasibility of a process to ensure personnel, materials, facilities, Software Engineering Environment (SEE) and technology required to execute and manage a project are available, adequate and appropriate; and the predetermined times for completion are achievable, timely and economical. This involves choosing a software development strategy (e.g., a project may consist of off-the-shelf software, in-house software, out-sourced software or a combination of these).

Scope (e.g., description of a project product, product characteristics and how the characteristics are to be measured or assessed) related items aim to:

- Document the reason for the project, its goals and its objectives.
- Translate stakeholder requirements into project deliverables and activities to be carried out to achieve and organize a project.
- Ensure people work within the scope.
- Evaluate the results of activities to facilitate the results meeting scope requirements.

In the best case scenario, a new software project has many similarities to a project previously managed by an organization. This provides a high level of assurance that an organization has the capability to perform a software project successfully.

Initiation and scope definition may be difficult to perform when a new project is unprecedented (i.e., has not previously been performed by an organization). For an unprecedented project, special care should be taken to ensure it is properly scoped and monitored. This should be accomplished by having frequent reviews and evaluations, reviewing best practices and lessons learned from somewhat related projects, and by seeking advice from experts.

The key to initiation and scope definition is to establish and document the comprehensive scope and requirements of a software project. This involves identifying and understanding stakeholder requirements, and evaluating and negotiating comprehensive requirements. Special care should be taken to manage change to the scope and requirements throughout a software project’s life cycle. All changes in scope and requirements should be carefully

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evaluated for the impact on cost, schedule, risk and performance. All stakeholders should be involved in the requirements definition of a software project.

Special care should be applied to defining and documenting quality characteristics [19]; for example, when software is to be embedded in a higher-level system, or functions are to be distributed between software and hardware, or between software and external interfacing software or systems.

Responsibility for obtaining stakeholder agreement on project requirements should be determined. Agreement is the result of an iterative process to be employed throughout a software project life cycle. Risks, changes in stakeholder requirements, environment, project budget and schedule, and an evolving design make it necessary to continually reassess and reaffirm agreements and commitments, and make appropriate changes to the project scope, as required.

Establishing completion criteria is very important. The intent, as supported by [11], is to determine if a project, activity or task has been completed successfully.

A business requirement, often ignored by software PMs, is the handling of copyrights, patents, etc. For instance, when does an acquirer own a developing product or what does an acquirer own when a supplier goes out of business prior to final product delivery?

Software specific advice:

— Requirements for software replication, distribution, installation and testing should be carefully determined.

— Traceability between system and software requirements, between software requirements and design, and between software requirements and tests should be established and maintained.

— Interfaces should be specified and controlled as an integral part of software specification and interface description documents.

— Due to the complexity of software development, it is difficult to prove software products meet all user requirements (needs and expections).

— Workload projection depends on the type of project: a new development, embedding in or integration to a system, modification of off-the-shelf software product, porting to different operating systems, etc.

6.2.2 Planning

ISO/IEC 12207

7.1.2 Planning. This activity consists of the following task:

7.1.2.1 The manager shall prepare the plans for execution of the process. The plans associated with the execution of the process shall contain descriptions of the associated activities and tasks and identification of the software products that will be provided. These plans shall include, but are not limited to, the following:

a) Schedules for the timely completion of tasks;
b) Estimation of effort;
c) Adequate resources needed to execute the tasks;
d) Allocation of tasks;
e) Assignment of responsibilities;
f) Quantification of risks associated with the tasks or the process itself;
g) Quality control measures to be employed throughout the process;
h) Costs associated with the process execution;
i) Provision of environment and infrastructure.

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The responsibility for preparing and approving plans should be defined.

Plans should identify the software life cycle model, task, task assignments, commitments and resources. A software project should have one master schedule and all subordinate schedules should be integrated and consistent with the master schedule. A WBS can effectively measure software project progress and provides visibility into processes and products. A WBS technique is strongly encouraged because it organizes and defines the total scope of the project [11]. The WBS should be constructed to allow a software project to be managed at the appropriate level of granularity consistent with the size, complexity, criticality and risk of the software project; familiarity is needed on the technology to be used.

Project estimates used in planning should include:

— Costs associated with process execution.

— Infrastructure.

— Need for resources, including related management and control.

— Quality assurance and control.

— Risk management.

— SEE provisions.

— Work to be performed in each process and/or activity.

Software PMs should make every attempt to use existing organizational infrastructure whenever possible. If existing infrastructure is insufficient to support a project, then adaptation or additions to existing infrastructure should be handled judiciously. This may require the use of subcontracting to satisfy infrastructure deficiencies. Consultants may help bringing agreement on various matters.

Planning is an iterative activity in which a software project is assessed, refined and revised (as necessary) as project execution progresses. Software PMs should have processes in place to facilitate re-planning and refinement of estimates throughout a software project life cycle. There are many interdependencies on every software project and several iterations of planning are usually required to obtain even an initial SPM plan. For information needed by an SPM plan, but provided in other plans, an SPM plan may reference the other plans.

Plans should be updated and at least contain:

— Roles and Responsibilities.

— Activities and tasks to be performed.

— All project deliverables identified in a WBS.

— Completion criteria.

— Completion reporting.

— Cost and schedule reporting.

— Means of initiation - by direction, product or time-based.

— Frequency and means of reporting progress.

— Problem or exception reporting.

— Resource requirements and status.

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Supporting Process managers should develop documented plans since Supporting Processes (e.g., Configuration Management, Documentation, Quality Assurance) are normally part of a project. Supporting Process plans should be aligned with and support the SPM plan, and may be separate plans or may be included in a SPM plan. These documented plans should be approved by the software PM and placed under project change control.

Activity reporting related to Supporting Processes should be given to the software PM either directly or through organizational management. Problem or exception reports should be brought to the attention of the software PM for impact analysis on a project's cost, schedule, scope and quality. There should exist a mechanism for conflict resolution or escalation so an appropriately authorized level of organizational management may resolve disagreements between the software PM and Supporting Process management.

Where milestones are in place and achievement of milestones is dependent upon one or more reports and/or outcomes from any Supporting Process, it is important that these achievements are reported in an accurate and timely manner in accordance with approved plans. Since it is common for milestones to be contractually linked to performance of Supporting Processes (for example achievement of a particular baseline), it is essential the plans be synchronized and the software PM be made aware (as soon as possible) of any difficulties experienced by Supporting Processes in completing assigned tasks.

Whenever Supporting Processes are performed by organizations outside the direct organizational control of the software PM, it is important to realize the existence of two sets of relationships between: 1) the software PM and the Supporting Process management, and 2) the supported and supporting organizational management. The software PM should recognize this when considering aspects of planning, implementation, control and reporting through clearly defined technical and management reporting, information flow and dispute resolution. Synchronization of plans may be more difficult under subcontract agreements and tasking, but can be aided by having one master plan.

Historical project data are the main source for analysing and understanding organizational process capability and efficiency, historical project performance and lessons learned. These historical data form a global database an organization should use to continuously improve Organizational Life Cycle Processes. The same database should support the execution of the Management Process for individual software projects. Every organization should establish a formal system to collect, analyse, summarize, archive and retrieve historical project data.

Software specific advice:

- Since an effective configuration management strategy is critical to software projects, the following strategies may be used as part of a change control process to manage changes:
  - A change threshold should be established allowing incorporation of any software change costing less than a specified amount without requiring a modification to a contract.
  - A batch-for-change grouping of changes should be used for easy incorporation of changes to minimize schedule impacts on development and to maximize stability.
  - Agreement on interfaces should be obtained at project commitment and throughout a project to deal with chronic problems of vague, inaccurate, changing or un-testable requirements and specifications.
- Most cost models are based on estimated software volume. The real problem is determining the volume and calibrating the model for a specific project. To do this well, the following should be considered:
  - Data collected from previous projects.
  - The use of an expert to operate and interpret the model.
  - If not calibrated to a project's organizational experience, a cost model may be in error by up to an order of magnitude.
  - Under no circumstances should one cost model be relied on to produce the final cost estimate.

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- Software systems are difficult to visualize, thus making the effect of change difficult to predict and manage.
- Software needs to be “packaged” to facilitate its efficient and effective replication, distribution, installation, testing and operation.
- Software plans should be closely tied to those for hardware and must be managed together, notwithstanding the fact they may be executed by different organizations. In particular, milestones must be linked and decided upon with full consultation between hardware and software developers to limit possibilities of one area causing a project delay.
- Plans for software need to be closely tied to the plans of the customer, host hardware and environment.

— When procuring software resources determine:

- If maintenance and version upgrades are free.
- Ownership rights, e.g., warranty, intellectual rights, patents and copyrights.

6.2.3 Execution and control

ISO/IEC 12207

7.1.3 Execution and control. This activity consists of the following tasks:

7.1.3.1 The manager shall initiate the implementation of the plan to satisfy the objectives and criteria set, exercising control over the process.

7.1.3.2 The manager shall monitor the execution of the process, providing both internal reporting of the process progress and external reporting to the acquirer as defined in the contract.

7.1.3.3 The manager shall investigate, analyse, and resolve the problems discovered during the execution of the process. The resolution of problems may result in changes to plans. It is the manager’s responsibility to ensure the impact of any changes is determined, controlled, and monitored. Problems and their resolution shall be documented.

7.1.3.4 The manager shall report, at agreed points, the progress of the process, declaring adherence to the plans and resolving instances of the lack of progress. These include internal and external reporting as required by the organizational procedures and the contract.

This activity normally begins when the software PM authorizes expenditure (or the additional expenditure) of funds.

The software PM should be responsible for monitoring the effort in the control portion of this activity to ensure any deviation from documented planned performance is identified and analysed promptly, and suitable corrective action is undertaken to bring the process back under control. The software PM should use the control portion of this activity to take corrective action to resolve emerging problems and to take preventive action to thwart anticipated problems with process execution. Software measurement (e.g., metrics), the change control process, and software product and process evaluations and audits are instrumental in monitoring and controlling project execution. Software measurements can be used to validate the expected software product functions versus the service to be done.

NOTE Interface Control Working Groups (ICWGs), for example, are essential for successful execution, evaluation of interface constraints and control of software projects. ICWGs should consist of a representative from each organization affected by an interface. ICWGs provide a forum to discuss software and system interfaces, explore options and reach agreement on the best approach for implementing interfaces. ICWG recommendations requiring project changes should be presented to a Configuration Control Board (CCB) for approval prior to implementation.

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The software PM should be responsible for satisfying communication requirements, including timely progress reporting to stakeholders, promulgation of revisions to plans and work authorization, and deviation reporting and documenting, as necessary. Centralized, up-to-date databases are useful to facilitate exchanges between people.

The software PM should ensure software projects are completed within the agreed time limits to satisfy stakeholder requirements. The software PM should determine, in conjunction with stakeholders, the overriding objective of a software project. A project's ultimate objective may not result in the option of ensuring the least time or cost to complete a project, e.g., safety critical systems require intense testing.

Risk-related processes (management of project risk) deal with uncertainties in planning throughout a project and requires a structured approach. The aim of risk-related processes is to minimize the impact of potential negative events and to take full advantage of opportunities for improvement. Risks are related either to the project processes or tools, or to the compliance of the product with project objectives.

Software specific advice:

— Recovery from a schedule slip needs to be carefully assessed and should not be expected without a negative impact on performance, cost or risk.

— Adding more personnel to a late software project could make it later, depending on the capability of the new personnel.

— To mitigate risk, demonstrations permit acquirers and customers to experience the capabilities of a software product prior to selection of a supplier.

— Use prototyping to develop a portion of the software functionality to demonstrate the functionality executes properly.

— Critical system engineering efforts should not be conducted without sufficient software engineering expertise.

— In cooperation with stakeholders, review the software requirements baseline regularly throughout a project to ensure compliance with or adjustment to the objectives (cost, time and performance).

— The number of people and teams on a project should be linked to the budget and schedule, and normal spans of control should not be exceeded.

— As a result of software being difficult to visualize, there are many difficulties with the evaluation of progress. Managers should define and refine techniques to determine progress, so as to allow early detection of cost or schedule overruns.

— Since software development and maintenance activities are often dependent on individual skills and experience, managers should try to prevent unneccessary substitution of staff on in-progress work items.

— Constant communications with stakeholders is essential to minimize surprises in performance, cost and schedule.

6.2.4 Review and evaluation

ISO/IEC 12207

7.1.4 Review and evaluation. This activity consists of the following tasks:

7.1.4.1 The manager shall ensure that the software products and plans are evaluated for satisfaction of requirements.

7.1.4.2 The manager shall assess the evaluation results of the software products, activities, and tasks completed during the execution of the process for achievement of the objectives and completion of the plans.

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ISO/IEC 12207's Supporting Processes (e.g., Joint Review and Audit Processes) supplements the Review and Evaluation activity.

The software PM should be responsible for ensuring software products and plans are evaluated for:

— Assessing the review results of software products, activities and tasks.

— Complying with SPM plans, philosophy, methodology and technology.

— Documenting plans and commitments.

— Satisfying requirements.

— Readiness for advancement to the next process, activity or task.

The software PM should participate in critical reviews. SPM plans should be the basis for tracking software project processes and activities. A combination of event- and schedule-driven criteria may be used to manage review activities.

Periodic review and evaluation of work-in-progress and work-to-be-completed is an essential element for successful software projects. The software PM should validate the expected software product functions versus the service to be performed. The software PM should select a set of software measurements to provide meaningful insight into the progress throughout a software life cycle. Progress should be determined primarily by comparing actual measurements of software work product size, effort, cost, schedule, units completed, or build content with estimates documented in a SPM plan and to the amount of work to be completed. The software PM should direct performance reviews of software project teams and should provide periodic progress reviews to provide status for stakeholders. Use of proper tools can be of great assistance to a review and evaluation activity.

Evaluation of work-in-progress is best performed by personnel familiar with the project requirements, technologies involved, product, requirements, and processes and infrastructure being used. Management reviews should cover project activities in support of a software life cycle. Top-level reviews should rely heavily on functional/technical level reviews and should be used to form an overall software project assessment.

Management review of schedule performance, especially software package progress, should be structured and performed to provide realistic assessments. Use of software measurements; earned value analysis; and results from inspections, walkthroughs, and joint and peer reviews are essential for meaningful software package assessments to support an accurate project assessment.

Documenting significant issues, action items and decisions resulting from reviews and evaluations should be required. Action items and significant issues should be tracked to closure and problems identified should be entered into a project corrective action system.

Software measurements and change controls are instrumental in managing and controlling software project execution. The software PM should institute a software measurement program to provide a framework for risk identification, quantification and assessment. The software PM should choose appropriate software risk measurements to provide meaningful insight into software project risks throughout a software life cycle. In general, reviews and evaluations should be performed to determine technical and business risk areas.

Guidance on quality system elements, concepts and practices is important to, and has an impact on, the practice of project management. Projects consist of processes and an action in a process usually affects other processes. Overall management of interdependencies among project processes is the responsibility of software PMs.

Software specific advice:

— Any schedule slippage prior to commencement of testing, without a corresponding slippage in delivery date, may result in a project being unable to complete testing according to plans.

— Establish a comprehensive test plan early in the software project life cycle.

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— Rigorous rules are required for the registration, storage, updating, backup and maintenance of programs, test data and the test environment.

— Develop a regression strategy for testing modifications.

— Develop an integration plan to build system and software units according to a release strategy.

— Evidence of software and host system capacities should be provided so these capacities are shown to be adequate to meet the customer's current and planned needs.

— Test cases and results used in the Development Process should be kept to assist the Maintenance Process.

6.2.5 Closure

ISO/IEC 12207

7.1.5 Closure. This activity consists of the following tasks:

7.1.5.1 When all software products, activities, and tasks are completed, the manager shall determine whether the process is complete taking into account the criteria as specified in the contract or as part of an organization's procedure.

7.1.5.2 The manager shall check the results and records of the software products, activities, and tasks employed for completeness. These results and records shall be archived in a suitable environment as specified in the contract.

SPM should be responsible for assessing completion of a project and for ensuring project requirements, criteria and procedures have been satisfied. This determination may be made when a software product, process, activity or task has been successfully completed. The results and records of the software products, processes, activities or tasks should be checked for completeness; and once deemed complete, should be archived per the contract and/or organizational requirements.

The closure activity should use the results, with associated data and reports, of (for example) the following:

— Software acceptance testing, verification, validation and software measurements.

— Software quality assurance reports and operational testing.

— Software trouble reports.

— Audits.

— Acceptance and sign-off.

— Stakeholder comments/feedback.

Early consideration should be given to maintaining baselines, documents and records after closure, e.g., location, media and how long to keep the information.

Closure can occur between processes, activities and tasks. As stated in [11] (for ISO/IEC 12207, substitute process, activity or task for the term "phase"):

> *The conclusion of a project phase is generally marked by a review of both key deliverables and project performance in order to a) determine if the project should continue into its next phase and b) detect and correct errors cost effectively.*

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It is important, during and at the conclusion of each project, that the lessons learned are not only captured and analysed, but also made accessible to the entire organization to promote process improvement. This should help the management and process techniques deal with changing technology.

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Annex A
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Support of the ISO/IEC 12207 Management Process

Table A.1 identifies where ISO/IEC 12207's five Primary Life Cycle Processes support the Management Process activities.

NOTE 1 A mapping at a high level (e.g., 5.2) flows down to all lower levels (e.g., 5.2.3).

NOTE 2 In this table: X = Objective mapping and O = Subjective mapping (There may be some disagreement.)

Table A.1 — ISO/IEC 12207 supports the ISO/IEC 12207 Management Process activities

5 Primary Life Cycle Processes	7.1 Management Process Activities				
	7.1.1 Initiation and Scope definition	7.1.2 Planning	7.1.3 Execution and Control	7.1.4 Review and Evaluation	7.1.5 Closure
5.1 Acquisition Process					
5.1.1 Initiation	X				
5.1.1.5 Use Development Process			X		
5.1.1.8 Acquisition plan		X			
5.1.2 Request for proposal [-tender] preparation	X	X			
5.1.3 Contract preparation and update	X		X		
5.1.3.5 Control and evaluate changes				X	
5.1.4 Supplier monitoring			X	X	
5.1.5 Acceptance and completion				X	X
5.2 Supply Process					
5.2.1 Initiation	X				
5.2.2 Preparation of response	X				
5.2.3 Contract	X			O	
5.2.4 Planning		X			
5.2.5 Execution and control			X	O	
5.2.6 Review and evaluation				X	
5.2.7 Delivery and completion					X
5.3 Development Process			X		
5.3.1 Process Implementation	X				
5.3.1.1 Select life cycle model and map activities		X			
5.3.1.4 Develop and execute process plans		X			
5.3.2.2 Evaluate system requirements				X	
5.3.3.2 Evaluate system architecture and requirements				X	
5.3.4.2 Evaluate software requirements				X	
5.3.4.3 Conduct software requirements joint reviews				X	
5.3.5.6 Evaluate software item architecture, and interface and database designs				X	
5.3.5.7 Conduct software architecture design joint reviews				X	
5.3.6.7 Evaluate software detailed design and test requirements				X	
5.3.6.8 Conduct software detailed design joint reviews				X	
5.3.7.5 Evaluate software code and test results				X	
5.3.8.1 Develop integration plan		X			

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5 Primary Life Cycle Processes	7.1 Management Process Activities				
	7.1.1 Initiation and Scope definition	**7.1.2 Planning**	**7.1.3 Execution and Control**	**7.1.4 Review and Evaluation**	**7.1.5 Closure**
5.3.8.5 Evaluate integration plan, design, code, tests, test results and user documentation				**X**	
5.3.8.6 Conduct software integration joint reviews				**X**	
5.3.9.3 Evaluate design, code, tests, test results and user documentation				**X**	
5.3.9.4 Support software qualification testing audits				**X**	
5.3.10.3 Evaluate integrated system				**X**	
5.3.11.2 Evaluate system				**X**	
5.3.11.3 Support system qualification testing audits				**X**	
5.3.12.1 Develop software installation plan	**O**	**X**			
5.3.13.1 Support acquirer's acceptance review and testing of software products				**X**	
5.4 Operation Process			**X**		
5.4.1 Process implementation		**X**			
5.5 Maintenance Process					
5.5.1 Process implementation			**X**		
5.5.1.1 Develop and execute maintenance plans and procedures		**X**			
5.5.1.2 Establish procedures for receiving, recording and tracking problem reports and modification requests; and provide feedback		**X**			
5.5.2 Problem and modification analysis			**X**		
5.5.2.1 Analyze problem reports or modification requests				**X**	
5.5.2.3 Consider options for implementing modifications	**X**				
5.5.3 Modification implementation			**X**		
5.5.4 Maintenance review/acceptance				**X**	
5.5.5 Migration			**X**		
5.5.5.2 Develop and execute migration plan		**X**			
5.5.5.6 Perform-post operation review				**X**	
5.5.6 Software retirement			**X**		**X**
5.5.6.1 Develop and execute retirement plan		**X**			

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Annex B
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SPM activities mapped to the Management Process activities

Table B.1 identifies the [11] processes that apply to the ISO/IEC 12207 Management Process activities.

Table B.1 — Project management knowledge area processes support ISO/IEC 12207 Management Process activities

		7.1 ISO/IEC 12207 Management Process Activities				
Project Management Knowledge Areas	**Project Management Knowledge Area Processes**	**7.1.1 Initiation and Scope definition**	**7.1.2 Planning**	**7.1.3 Execution and Control**	**7.1.4 Review and Evaluation**	**7.1.5 Closure**
4. Project Integration Management	4.1 Project Plan Development	X	X			
	4.2 Project Plan Execution			X	X	
	4.3 Overall Change Control			X	X	
5. Project Scope Management	5.1 Initiation	X		X		
	5.2 Scope Planning	X	X			
	5.3 Scope Definition	X	X			
	5.4 Scope Verification	X			X	X
	5.5 Scope Change Control	X	X	X	X	
6. Project Time Management	6.1 Activity Definition	X	X			
	6.2 Activity Sequencing		X			
	6.3 Activity Duration Estimating		X	X	X	
	6.4 Schedule Development		X			
	6.5 Schedule Control			X	X	
7. Project Cost Management	7.1 Resources Planning	X	X			
	7.2 Cost Estimating	X	X	X		
	7.3 Cost Budgeting		X			
	7.4 Cost Control			X	X	
8. Project Quality Management	8.1 Quality Planning	X	X			
	8.2 Quality Assurance			X	X	
	8.3 Quality Control			X	X	
9. Project Human Resource Management	9.1 Organizational Planning	X	X		X	
	9.2 Staff Acquisition	X		X		
	9.3 Team Development	X		X		
10. Project Communications Management	10.1 Communications Planning	X	X			
	10.2 Information Distribution			X		
	10.3 Performance Reporting			X	X	
	10.4 Administrative Closure			X		X
11. Project Risk Management	11.1 Risk Identification	X		X		
	11.2 Risk Quantification	X		X		
	11.3 Risk Response Development		X	X	X	
	11.4 Risk Response Control	X	X	X	X	
12. Project Procurement Management	12.1 Procurement Planning	X	X			
	12.2 Solicitation Planning	X	X			
	12.3 Solicitation	X		X		
	12.4 Source Selection	X		X	X	
	12.5 Contract Administration			X	X	
	12.6 Contract Close-out		X			X

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Annex C
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Project Management Processes mapped to the ISO/IEC 12207 Management Process activities

Table C.1 identifies the [5] project management processes that apply to the ISO/IEC 12207 Management Process activities.

NOTE In this table: X = Objective mapping and O = Subjective mapping (There may be some disagreement.)

Table C.1 — Project Management Processes support the ISO/IEC 12207 Management Process activities

ISO 10006		7.1 ISO/IEC 12207 Management Process Activities				
Project Management Process Groups	**Project Management Processes**	**7.1.1 Initiation and Scope definition**	**7.1.2 Planning**	**7.1.3 Execution and Control**	**7.1.4 Review and Evaluation**	**7.1.5 Closure**
5.3 Interdependency management processes	5.3.1 Project initiation and project plan development	X	X		X	
	5.3.2 Interaction management		X	X	X	
	5.3.3 Change management	X		X	X	
	5.3.4 Closure				X	X
5.4 Scope-related processes	5.4.1 Concept development	X				
	5.4.2 Scope development and control	X	X		X	
	5.4.3 Activity definition		X			
	5.4.4 Activity control			X	X	
5.5 Time-related processes	5.5.1 Activity dependency planning		X		X	
	5.5.2 Estimation of duration		X			
	5.5.3 Schedule development		X			
	5.5.4 Schedule control		X	X	X	
5.6 Cost-related processes	5.6.1 Cost estimation		X			
	5.6.2 Budgeting		X			
	5.6.3 Cost control		X	X	X	
5.7 Resource related Processes	5.7.1 Resource planning		X			
	5.7.2 Resource control		X	X	X	
5.8 Personnel-related processes	5.8.1 Definition of project organizational structure		X			
	5.8.2 Staff allocation		X		O	
	5.8.3 Team development	O				
5.9 Communication-related processes	5.9.1 Communication planning	O	O			
	5.9.2 Information management		X	X		
	5.9.3 Communication control			O	O	
5.10 Risk-related processes	5.10.1 Risk identification	O	X			
	5.10.2 Risk assessment		X			
	5.10.3 Risk response development		X			
	5.10.4 Risk control			O	O	
5.11 Purchasing-related processes	5.11.1 Purchasing planning and control	O	X			
	5.11.2 Documentation of requirements		O		X	
	5.11.3 Evaluation of subcontractors	O		O	X	
	5.11.4 Subcontracting	O	X	X	X	
	5.11.5 Contract control			X	X	

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Annex D
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Supporting information

D.1 Introduction

Annex D provides additional information on management knowledge in [5] and [11] data. For Table D.1, ISO/IEC 12207 data is at the activity level; [5] data is at the process level; and [11] data is at the project management knowledge level. For a definition of the terms used in Table D.1: Section D.2 defines the [11] terms and Section D.3 defines the [5] terms.

Table D.1 — ISO/IEC 12207 mapped to ISO 10006 and *PMBOK™ Guide* project management knowledge areas

ISO/IEC 12207 Process Activities	ISO 10006 Process Levels	*PMBOK™ Guide Project Management Knowledge Areas*
5.1 Acquisition		
5.1.1 Initiation	5.3 Interdependency management processes	4 Project Integration Management
	5.4 Scope-related processes	5 Project Scope Management
	5.6 Cost-related processes	7 Project Cost Management
	5.8 Personnel-related processes	9 Project Human Resource Management
	5.10 Risk-related processes	11 Project Risk Management
	5.11 Purchasing-related processes	12 Project Procurement Management
5.1.2 Request for proposal (-tender) preparation	5.3 Interdependency management processes	4 Project Integration Management
	5.4 Scope-related processes	5 Project Scope Management
	5.5 Time-related processes	6 Project Time Management
	5.8 Personnel-related processes	9 Project Human Resource Management
	5.11 Purchasing-related processes	12 Project Procurement Management
5.1.3 Contract preparation and update	5.3 Interdependency management processes	4 Project Integration Management
	5.5 Time-related processes	6 Project Time Management
	5.6 Cost-related processes	7 Project Cost Management
	5.10 Risk-related processes	8 Project Quality Management
	5.11 Purchasing-related processes	11 Project Risk Management
		12 Project Procurement Management
5.1.4 Supplier monitoring	5.5 Time-related processes	6 Project Time Management
	5.6 Cost-related processes	7 Project Cost Management
	5.7 Resource-related processes	8 Project Quality Management
	5.9 Communication-related processes	10 Project Communications Management
	5.11 Purchasing-related processes	12 Project Procurement Management
5.1.5 Acceptance and completion	5.3 Interdependency management processes	4 Project Integration Management
	5.11 Purchasing-related processes	8 Project Quality Management
		12 Project Procurement Management
5.2 Supply Process		
5.2.1 Initiation	5.4 Scope-related processes	5 Project Scope Management
5.2.2 Planned preparation of response	5.4 Scope-related processes	5 Project Scope Management
5.2.3 Contract	5.3 Interdependency management processes	4 Project Integration Management
	5.4 Scope-related processes	5 Project Scope Management

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ISO/IEC 12207 Process Activities	ISO 10006 Process Levels	*PMBOK™ Guide Project Management Knowledge Areas*
5.2.4 Planning	5.3 Interdependency management processes	4 Project Integration Management
	5.4 Scope-related processes	5 Project Scope Management
	5.5 Time-related processes	6 Project Time Management
	5.6 Cost-related processes	7 Project Cost Management
	5.7 Resource-related processes	8 Project Quality Management
	5.8 Personnel-related processes	9 Project Human Resource Management
	5.9 Communication-related processes	10 Project Communications Management
	5.10 Risk-related processes	11 Project Risk Management
	5.11 Purchasing-related processes	12 Project Procurement Management
5.2.5 Execution and control	5.3 Interdependency management processes	4 Project Integration Management
	5.5 Time-related processes	6 Project Time Management
	5.6 Cost-related processes	7 Project Cost Management
	5.7 Resource-related processes	8 Project Quality Management
	5.8 Personnel-related processes	9 Project Human Resource Management
	5.9 Communication-related processes	10 Project Communications Management
	5.10 Risk-related processes	11 Project Risk Management
	5.11 Purchasing-related processes	12 Project Procurement Management
5.2.6 Review and evaluation	5.3 Interdependency management processes	4 Project Integration Management
	5.9 Communication-related processes	8 Project Quality Management
	5.11 Purchasing-related processes	10 Project Communications Management
		12 Project Procurement Management
5.2.7 Delivery and completion	5.9 Communication-related processes	10 Project Communications Management
	5.11 Purchasing-related processes	12 Project Procurement Management
5.3 Development Process		
5.3.1 Process implementation	5.3 Interdependency management processes	4 Project Integration Management
	5.4 Scope-related processes	5 Project Scope Management
	5.8 Personnel-related processes	9 Project Human Resource Management
	5.9 Communication-related processes	10 Project Communications Management
	5.10 Risk-related processes	11 Project Risk Management
5.3.2 System requirements analysis	5.3 Interdependency management processes	8 Project Quality Management
	5.4 Scope-related processes	12 Project Procurement Management
	5.11 Purchasing-related processes	
5.3.3 System architectural design		5 Project Scope Management
		8 Project Quality Management
5.3.4 Software requirements analysis	5.3 Interdependency management processes	5 Project Scope Management
	5.4 Scope-related processes	8 Project Quality Management
	5.11 Purchasing-related processes	12 Project Procurement Management
5.3.5 Software architectural design	5.3 Interdependency management processes	4 Project Integration Management
	5.5 Time-related processes	6 Project Time Management
	5.6 Cost-related processes	7 Project Cost Management
	5.10 Risk-related processes	8 Project Quality Management
		10 Project Communications Management
		11 Project Risk Management

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ISO/IEC 12207 Process Activities	ISO 10006 Process Levels	*PMBOK™ Guide Project Management Knowledge Areas*
5.3.6 Software detailed design	5.3 Interdependency management processes	4 Project Integration Management
	5.5 Time-related processes	6 Project Time Management
	5.6 Cost-related processes	7 Project Cost Management
	5.10 Risk-related processes	8 Project Quality Management
		10 Project Communications Management
		11 Project Risk Management
5.3.7 Software coding and testing	5.3 Interdependency management processes	4 Project Integration Management
	5.5 Time-related processes	6 Project Time Management
	5.6 Cost-related processes	7 Project Cost Management
	5.10 Risk-related processes	8 Project Quality Management
		10 Project Communications Management
		11 Project Risk Management
5.3.8 Software integration	5.3 Interdependency management processes	4 Project Integration Management
	5.5 Time-related processes	6 Project Time Management
	5.6 Cost-related processes	7 Project Cost Management
	5.10 Risk-related processes	8 Project Quality Management
		10 Project Communications Management
		11 Project Risk Management
5.3.9 Software qualification testing	5.3 Interdependency management processes	4 Project Integration Management
	5.5 Time-related processes	6 Project Time Management
	5.6 Cost-related processes	7 Project Cost Management
	5.10 Risk-related processes	8 Project Quality Management
		10 Project Communications Management
		11 Project Risk Management
5.3.10 System integration	5.3 Interdependency management processes	4 Project Integration Management
	5.5 Time-related processes	6 Project Time Management
	5.6 Cost-related processes	7 Project Cost Management
	5.10 Risk-related processes	8 Project Quality Management
		10 Project Communications Management
		11 Project Risk Management
5.3.11 System qualification testing	5.3 Interdependency management processes	4 Project Integration Management
	5.5 Time-related processes	6 Project Time Management
	5.6 Cost-related processes	7 Project Cost Management
	5.10 Risk-related processes	8 Project Quality Management
		10 Project Communications Management
		11 Project Risk Management
5.3.12 Software installation	5.3 Interdependency management processes	4 Project Integration Management
	5.9 Communication-related processes	8 Project Quality Management
	5.11 Purchasing-related processes	10 Project Communications Management
		12 Project Procurement Management
5.3.13 Software acceptance support	5.3 Interdependency management processes	4 Project Integration Management
	5.9 Communication-related processes	8 Project Quality Management
	5.11 Purchasing-related processes	10 Project Communications Management
		12 Project Procurement Management
5.4 Operation process		
5.4.1 Process implementation	5.3 Interdependency management processes	4 Project Integration Management
	5.4 Scope-related processes	5 Project Scope Management
	5.5 Time-related processes	6 Project Time Management
	5.8 Personnel-related processes	8 Project Quality Management
		9 Project Human Resource Management

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ISO/IEC 12207 Process Activities	ISO 10006 Process Levels	*PMBOK™ Guide Project Management Knowledge Areas*
5.4.2 Operational testing		8 Project Quality Management
5.4.3 System operation		8 Project Quality Management
5.4.4 User support	5.3 Interdependency management processes	10 Project Communications Management
	5.9 Communication-related processes	11 Project Risk Management
	5.10 Risk-related processes	
5.5 Maintenance Process		
5.5.1 Process implementation	5.3 Interdependency management processes	4 Project Integration Management
	5.4 Scope-related processes	5 Project Scope Management
	5.5 Time-related processes	6 Project Time Management
	5.8 Personnel-related processes	8 Project Quality Management
	5.9 Communication-related processes	9 Project Human Resource Management
		10 Project Communications Management
5.5.2 Problem and modification analysis	5.5 Time-related processes	6 Project Time Management
	5.6 Cost-related processes	7 Project Cost Management
	5.9 Communication-related processes	8 Project Quality Management
	5.10 Risk-related processes	10 Project Communications Management
		11 Project Risk Management
5.5.3 Modification implementation	5.3 Interdependency management process	4 Project Integration Management
	5.9 Communication-related processes	8 Project Quality Management
		10 Project Communications Management
5.5.4 Maintenance review/ acceptance	5.3 Interdependency management process	4 Project Integration Management
	5.4 Scope-related processes	5 Project Scope Management
	5.9 Communication-related processes	8 Project Quality Management
5.5.5 Migration	5.3 Interdependency management processes	4 Project Integration Management
	5.9 Communication-related processes	8 Project Quality Management
		10 Project Communications Management
5.5.6 Software retirement	5.3 Interdependency management processes	4 Project Integration Management
	5.9 Communication-related processes	8 Project Quality Management
		10 Project Communications Management
6.1 Documentation Process		
6.1.1 Process implementation	5.3 Interdependency management processes	4 Project Integration Management
	5.5 Time-related processes	6 Project Time Management
	5.8 Personnel-related processes	8 Project Quality Management
	5.9 Communication-related processes	9 Project Human Resource Management
		10 Project Communications Management
6.1.2 Design and development	5.9 Communication-related processes	8 Project Quality Management
		10 Project Communications Management
6.1.3 Production	5.3 Interdependency management processes	4 Project Integration Management
	5.9 Communication-related processes	10 Project Communications Management
6.1.4 Maintenance	5.3 Interdependency management processes	4 Project Integration Management
6.2 Configuration Management Process		
6.2.1 Process implementation	5.3 Interdependency management processes	4 Project Integration Management
	5.5 Time-related processes	6 Project Time Management
	5.8 Personnel-related processes	9 Project Human Resource Management
6.2.2 Configuration identification	5.3 Interdependency management processes	4 Project Integration Management

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ISO/IEC 12207 Process Activities	ISO 10006 Process Levels	*PMBOK™ Guide Project Management Knowledge Areas*
6.2.3 Configuration control	5.3 Interdependency management processes	4 Project Integration Management
	5.9 Communication-related processes	8 Project Quality Management
	5.10 Risk-related processes	10 Project Communications Management
		11 Project Risk Management
6.2.4 Configuration status accounting	5.9 Communication-related processes	10 Project Communications Management
6.2.5 Configuration evaluation	5.3 Interdependency management processes	8 Project Quality Management
	5.10 Risk-related processes	11 Project Risk Management
6.2.6 Release management and delivery	5.9 Communication-related processes	10 Project Communications Management
6.3 Quality Assurance Process		
6.3.1 Process implementation	5.3 Interdependency management processes	4 Project Integration Management
	5.5 Time-related processes	6 Project Time Management
	5.8 Personnel-related processes	8 Project Quality Management
	5.9 Communication-related processes	9 Project Human Resource Management
		10 Project Communications Management
6.3.2 Product assurance	5.3 Interdependency management processes	8 Project Quality Management
6.3.3 Process assurance	5.3 Interdependency management processes	8 Project Quality Management
	5.8 Personnel-related processes	9 Project Human Resource Management
	5.9 Communication-related processes	10 Project Communications Management
	5.11 Purchasing-related processes	
6.3.4 Assurance of quality systems	5.3 Interdependency management processes	8 Project Quality Management
6.4 Verification Process		
6.4.1 Process implementation	5.3 Interdependency management processes	4 Project Integration Management
	5.5 Time-related processes	6 Project Time Management
	5.8 Personnel-related processes	8 Project Quality Management
	5.9 Communication-related processes	9 Project Human Resource Management
	5.10 Risk-related processes	10 Project Communications Management
		11 Project Risk Management
6.4.2 Verification	5.3 Interdependency management processes	4 Project Integration Management
	5.8 Personnel-related processes	8 Project Quality Management
	5.9 Communication-related processes	9 Project Human Resource Management
	5.10 Risk-related processes	10 Project Communications Management
	5.11 Purchasing-related processes	11 Project Risk Management
		12 Project Procurement Management
6.5 Validation Process		
6.5.1 Process implementation	5.3 Interdependency management processes	4 Project Integration Management
	5.5 Time-related processes	6 Project Time Management
	5.8 Personnel-related processes	8 Project Quality Management
	5.9 Communication-related processes	9 Project Human Resource Management
		10 Project Communications Management
6.5.2 Validation	5.3 Interdependency management processes	4 Project Integration Management
	5.9 Communication-related processes	8 Project Quality Management
	5.10 Risk-related processes	10 Project Communications Management
		11 Project Risk Management

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ISO/IEC 12207 Process Activities	ISO 10006 Process Levels	*PMBOK™ Guide Project Management Knowledge Areas*
6.6 Joint Review Process		
6.6.1 Process implementation	5.3 Interdependency management processes	4 Project Integration Management
	5.8 Personnel-related processes	9 Project Human Resource Management
	5.9 Communication-related processes	10 Project Communications Management
6.6.2 Project management reviews	5.3 Interdependency management processes	4 Project Integration Management
	5.5 Time-related processes	6 Project Time Management
	5.9 Communication-related processes	8 Project Quality Management
	5.10 Risk-related processes	10 Project Communications Management
		11 Project Risk Management
6.6.3 Technical reviews	5.3 Interdependency management processes	4 Project Integration Management
	5.5 Time-related processes	6 Project Time Management
	5.9 Communication-related processes	8 Project Quality Management
		10 Project Communications Management
6.7 Audit Process		
6.7.1 Process implementation	5.3 Interdependency management processes	4 Project Integration Management
	5.4 Scope-related processes	5 Project Scope Management
	5.5 Time-related processes	6 Project Time Management
	5.8 Personnel-related processes	8 Project Quality Management
	5.9 Communication-related processes	9 Project Human Resource Management
		10 Project Communications Management
6.7.2 Audit	5.3 Interdependency management processes	4 Project Integration Management
	5.5 Time-related processes	6 Project Time Management
	5.6 Cost-related processes	7 Project Cost Management
		8 Project Quality Management
6.8 Problem Resolution Process		
6.8.1 Process implementation	5.9 Communication-related processes	8 Project Quality Management
		10 Project Communications Management
6.8.2 Problem resolution	5.9 Communication-related processes	8 Project Quality Management
		10 Project Communications Management
7.1 Management Process		
7.1.1 Initiation and scope definition	5.3 Interdependency management processes	4 Project Integration Management
	5.4 Scope-related processes	5 Project Scope Management
	5.8 Personnel-related processes	6 Project Time Management
	5.9 Communication-related processes	7 Project Cost Management
	5.10 Risk-related processes	8 Project Quality Management
	5.11 Purchasing-related processes	9 Project Human Resource Management
		10 Project Communications Management
		11 Project Risk Management
		12 Project Procurement Management
7.1.2 Planning	5.3 Interdependency management processes	4 Project Integration Management
	5.4 Scope-related processes	5 Project Scope Management
	5.5 Time-related processes	6 Project Time Management
	5.6 Cost-related processes	7 Project Cost Management
	5.7 Resource-related processes	8 Project Quality Management
	5.8 Personnel-related processes	9 Project Human Resource Management
	5.9 Communication-related processes	10 Project Communications Management
	5.10 Risk-related processes	11 Project Risk Management
	5.11 Purchasing-related processes	12 Project Procurement Management

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ISO/IEC 12207 Process Activities	ISO 10006 Process Levels	*PMBOK™ Guide Project Management Knowledge Areas*
7.1.3 Execution and control	5.3 Interdependency management processes	4 Project Integration Management
	5.4 Scope-related processes	5 Project Scope Management
	5.5 Time-related processes	6 Project Time Management
	5.6 Cost-related processes	7 Project Cost Management
	5.7 Resource-related processes	8 Project Quality Management
	5.9 Communication-related processes	9 Project Human Resource Management
	5.10 Risk-related processes	10 Project Communications Management
	5.11 Purchasing-related processes	11 Project Risk Management
		12 Project Procurement Management
7.1.4 Review and evaluation	5.3 Interdependency management processes	4 Project Integration Management
	5.4 Scope-related processes	5 Project Scope Management
	5.5 Time-related processes	6 Project Time Management
	5.6 Cost-related processes	7 Project Cost Management
	5.7 Resource-related processes	8 Project Quality Management
	5.9 Communication-related processes	10 Project Communications Management
	5.10 Risk-related processes	11 Project Risk Management
	5.11 Purchasing-related processes	12 Project Procurement Management
7.1.5 Closure	5.3 Interdependency management processes	5 Project Scope Management
		10 Project Communications Management
		12 Project Procurement Management
7.2 Infrastructure Process		
7.2.1 Process implementation	5.3 Interdependency management processes	4 Project Integration Management
	5.7 Resource-related processes	8 Project Quality Management
	5.8 Personnel-related processes	9 Project Human Resource Management
	5.9 Communication-related processes	10 Project Communications Management
7.2.2 Establishment of the infrastructure	5.3 Interdependency management processes	4 Project Integration Management
	5.5 Time-related processes	8 Project Quality Management
	5.6 Cost-related processes	9 Project Human Resource Management
	5.7 Resource-related processes	10 Project Communications Management
	5.8 Personnel-related processes	
	5.9 Communication-related processes	
7.2.3 Maintenance of the infrastructure	5.3 Interdependency management processes	4 Project Integration Management
	5.7 Resource-related processes	9 Project Human Resource Management
	5.9 Communication-related processes	10 Project Communications Management
7.3 Improvement Process		
7.3.1 Process establishment	5.3 Interdependency management processes	4 Project Integration Management
	5.4 Scope-related processes	10 Project Communications Management
	5.9 Communication-related processes	11 Project Risk Management
	5.10 Risk-related processes	
7.3.2 Process assessment	5.3 Interdependency management processes	4 Project Integration Management
	5.4 Scope-related processes	10 Project Communications Management
	5.9 Communication-related processes	11 Project Risk Management
	5.10 Risk-related processes	

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ISO/IEC 12207 Process Activities	ISO 10006 Process Levels	*PMBOK™ Guide Project Management Knowledge Areas*
7.3.3 Process improvement	5.3 Interdependency management processes	4 Project Integration Management
	5.4 Scope-related processes	7 Project Cost Management
	5.6 Cost-related processes	8 Project Quality Management
	5.9 Communication-related processes	10 Project Communications Management
	5.10 Risk-related processes	11 Project Risk Management
7.4 Training Process 7.4.1 Process implementation	5.5 Time-related processes	6 Project Time Management
	5.7 Resource-related processes	9 Project Human Resource Management
	5.8 Personnel-related processes	10 Project Communications Management
	5.9 Communication-related processes	
7.4.2 Training material development	5.9 Communication-related processes	10 Project Communications Management
7.4.3 Training plan implementation	5.8 Personnel-related processes	9 Project Human Resource Management
	5.9 Communication-related processes	10 Project Communications Management

D.2 Project Management Knowledge Area Process Definitions

The following is a list of [11] terms, and their definitions, as used in Tables B.1 and D.1:

Project Communications Management – A subset of project management that includes the processes required to ensure proper collection and dissemination of project information. It consists of communications planning, information distribution, performance reporting, and administrative closure.

Project Cost Management – A subset of project management that includes the processes required to ensure that the project is completed within the approved budget. It consists of resource planning, cost estimating, cost budgeting, and cost control.

Project Human Resource Management – A subset of project management that includes the processes required to make the most effective use of the people involved with the project. It consists of organizational planning, staff acquisition, and team development.

Project Integration Management – A subset of project management that includes the processes required to ensure that the various elements of the project are properly coordinated. It consists of project plan development, project plan execution, and overall change control.

Project Procurement Management – A subset of project management that includes the processes required to acquire goods and services from outside the performing organization. It consists of procurement planning, solicitation planning, solicitation, source selection, contract administration, and contract close-out.

Project Quality Management – A subset of project management that includes the processes required to ensure that the project will satisfy the needs for which it was undertaken. It consists of quality planning, quality assurance, and quality control.

Project Risk Management – A subset of project management that includes the processes concerned with identifying, analysing, and responding to project risk. It consists of risk identification, risk quantification, risk response development, and risk response control.

Project Scope Management – A subset of project management that includes the processes required to ensure that the project includes all of the work required, and only the work required, to complete the project successfully. It consists of initiation, scope planning, scope definition, scope verification, and scope change control.

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Project Time Management – A subset of project management that includes the processes required to ensure timely completion of the project. It consists of activity definition, activity sequencing, activity duration estimating, schedule development, and schedule control.

D.3 Quality in project management process definitions

The following is a list of selected [5] terms, and their definitions, as used in Tables C.1 and D.1:

Communication-related processes – These processes aim to facilitate the exchange of information necessary for the project. They ensure timely and appropriate generation, collection, dissemination, storage and ultimate disposition of project information. These processes are the following:

— communication planning: planning the information and communication systems of the project;

— information management: making necessary information available to project organization members and other relevant stakeholders;

— commmunication control: controlling communication in accordance with the planned communication system.

Cost-related processes – These processes aim to forecast and manage the project costs and to ensure that the project is completed within budget constraints and are the following:

— cost estimation: developing cost estimates for the project;

— budgeting: using results from cost estimation to produce the project budget;

— cost control: controlling costs and deviations from the project budget.

NOTE For further guidance, see ISO 10014.

Interdependency management processes – Projects consist of processes and an action in one of these usually affects others. The overall management of the interdependencies among the project processes is the responsibility of the project manager. The interdependency management processes are the following:

— project initiation and project plan development: evaluating customer and other stakeholder requirements, preparing a project plan and initiating other processes;

— interaction management: managing interactions during the project;

— change and configuration management: anticipating change and managing it across all processes;

— closure: closing processes and obtaining feedback.

Personnel-related processes – People determine the quality and success of the project. The personnel-related processes aim to create an environment in which people can contribute effectively to the project. These processes are the following:

— project organizational structure definition: defining a project organizational structure tailored to suit the project needs, including identifying roles in the project and defining authority and responsibility;

— staff allocation: selecting and assigning sufficient personnel with appropriate competence to suit the project needs;

— team development: developing individual and team skills and ability to enhance project performance.

NOTE The quantitative aspects of personnel management are covered in [Resource-related processes].

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Purchasing-related processes – These processes deal with the purchase, acquisition or procurement of products obtained for the project. The purchasing-related processes are the following:

— purchasing planning and control: identifying and controlling what is to be purchased and when;

— requirement documentation: compiling commercial conditions and technical requirements;

— subcontractor evaluation: evaluating and determining which subcontracts should be invited to tender;

— subcontracting: issuing invitations to tender, tender evaluation, negotiation, preparation and placing of the subcontrator;

— contract control: ensuring that subcontractors' performance meets contractual requirements.

NOTE 1 As noted in ISO 8402, the term 'product' includes service, hardware, processed materials, software or a combination thereof.

NOTE 2 For the purposes of [ISO 10006], and for reference to ISO 9004-1, the organization is the project organization, and subcontractors supply products to the project organization.

NOTE 3 Guidance, in addition to that given [in this Technical Report], can be found in clause 9 of ISO 9004-1:1994.

Resource-related processes – These processes aim to plan and control resources. They help to identify any possible problems with resources. Examples of resources include computer software, equipment, facilities, finance, information systems, materials, personnel, services and space. These processes are the following:

— resource planning: identifying, estimating, scheduling and allocating relevant resources;

— resource control: comparing actual usage against resource plans and taking action, if needed.

NOTE This subclause applies to the quantitative aspects of personnel management only when regarded as a resource. The other aspects are covered in [Personnel-related processes] because their management differs significantly from that of other resources.

Risk-related processes – Management of project risks deals with uncertainties throughout the project and requires a structured approach. The aim of the risk-related processes is to minimize the impact of potential negative events and to take full advantage of opportunities for improvement. In [ISO 10006], the term risk covers both aspects. Risks are related either to the project processes or to the project product. The risk-related processes are the following:

— risk identification: determining risks in the project;

— risk assessment: evaluating the probability of occurrence of risk events and the impact of risk events on the project;

— risk response development: developing plans for responding to risks;

— risk control: implementing and updating the risk plans.

It is particularly important that these processes and their output are documented.

Scope-related processes – For the purpose of [ISO 10006], "scope" includes a description of the project product, its characteristics and how they are to be measured or assessed. These processes aim to:

— translate the customer and other stakeholder requirements into activities to be carried out to achieve the objectives of the project and to organize these activities;

— ensure that people work within the scope, during the realization of the activities;

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— ensure that the activities carried out in the project meet the requirements described in the scope.

The scope-related processes are the following:

— concept development: defining the broad outlines of what the project product will do;

— scope development and control: documenting the characteristics of the project product in measurable terms and controlling them;

— activity definition: identifying and documenting activities and steps required to achieve the project objectives;

— activity control: controlling the actual work carried out in the project.

Time-related processes – These processes aim to determine dependencies and the duration of activities and to ensure timely completion of the project. They are the following:

— activity dependency planning: identifying inter-relationships and the logical interactions and dependencies among project activities;

— duration estimation: estimating the duration of each activity in connection with the specific conditions and with the resources required;

— schedule development: inter-relating the project time objectives, activity dependencies and their durations as the framework for developing general and detailed schedules;

— schedule control: controlling the realization of the project activities, for confirming the schedule or for taking adequate actions to recover from delays.

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Annex E
(informative)

Bibliography

The following publications have been selected because they are readily available from many public libraries and because they contain detailed information about certain topics relating to this Technical Report. Some of these publications are used as the basis for writing this Technical Report. Although some sections within these publications conflict with this Technical Report, they are a useful source of information. This list is not inclusive, nor an endorsement of any reference.

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