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Software and systems engineering — Tools and methods for product line product management

Ingénierie du logiciel et des systèmes — Outils et méthodes pour la gestion des gammes de produits

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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. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/IEC JTC 1, *Information technology,* Subcommittee SC 7*, Software and systems engineering.*

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at https://www.iso.org/members.html.

Introduction

Software and Systems Product Line (SSPL) engineering and management creates, exploits and manages a common platform to develop a family of products (e.g. software products, systems architectures) at lower cost, reduced time to market and with better quality. As a result, it has gained increasing global attention since the 1990s. Strategic management and supports are provided by product line product management for a product family and its evolution. Product management should collaborate with product line scoping process for the detailed definition of a product family. Also markets, technologies and competitors are carefully and continuously observed for product family definition and its continuous evolution. Product management deals with the economic aspects of product family and in particular with the market strategy.

There are needs for defining product line-specific product management processes that integrate the involved product line disciplines with those for a single product. Furthermore, support of tools and methods are required so that a product line organization can perform product management under the systematic control of complexities. This document addresses the product line-specific processes in product management by dividing those into product management enablement, product management operation and product management support process areas with the guidance of a set of tools and methods capabilities for supporting tasks for product line product management.

This document is intended to benefit people who acquire, supply, develop, operate, and maintain tools and methods for product line product management. This document can be used in one or more of the following modes:

— By an organization intended to implement or operate product lines – to understand, adopt and enact the processes, tools and methods for product line product management. This also helps the organization to evaluate and select relevant tools and methods based on business and user-related criteria.

— By a tool vendor who facilitates or leverages product line engineering practices – to provide a set of tool capabilities that should be embodied in a tool for supporting product management enablement, product management operation and product management support.

The ISO/IEC 26550 family of standards addresses both engineering and management processes and capabilities of methods and tools in terms of the key characteristics of product line development. This document provides processes and capabilities of methods and tools for variability mechanisms in product lines. Other standards in the ISO/IEC 26550 family are as follows:

ISO/IEC 26550, ISO/IEC 26551, ISO/IEC 26552, ISO/IEC 26553, ISO/IEC 26554, ISO/IEC 26555, ISO/IEC 26556, ISO/IEC 26557, ISO/IEC 26558, ISO/IEC 26559 are published. ISO/IEC 26561 and ISO/IEC 26562 are to be published. ISO/IEC 26563 is a planned International Standard.

— Processes and capabilities of methods and tools for domain requirements engineering and application requirements engineering are provided in ISO/IEC 26551;

— Processes and capabilities of methods and tools for domain design and application design are provided in ISO/IEC 26552;

— Processes and capabilities of methods and tools for domain realization and application realization are provided in ISO/IEC 26553;

— Processes and capabilities of methods and tools for domain testing and application testing are provided in ISO/IEC 26554;

— Processes and capabilities of methods and tools for technical management are provided in ISO/IEC 26555;

— Processes and capabilities of methods and tools for organizational management are provided in ISO/IEC 26556;

— Processes and capabilities of methods and tools for variability mechanism are provided in ISO/IEC 26557;

— Processes and capabilities of methods and tools for variability modelling are provided in ISO/IEC 26558;

— Processes and capabilities of methods and tools for variability traceability are provided in ISO/IEC 26559;

— Processes and capabilities of methods and tools for technical probe are provided in ISO/IEC 26561;

— Processes and capabilities of methods and tools for transition management are provided in ISO/IEC 26562;

— Processes and capabilities of methods and tools for configuration management of asset are provided in ISO/IEC 26563;

— Others (ISO/IEC 26564 to ISO/IEC 26599): To be developed.

Software and systems engineering — Tools and methods for product line product management

1 Scope

This document, within the context of methods and tools for product line product management**:**

— defines product line-specific processes and their subprocesses for product management of software and systems product lines. Those processes are described in terms of purpose, inputs, tasks and outcomes;

— defines method capabilities to support the defined tasks of each process;

— defines tool capabilities to automate/semi-automate tasks or defined method capabilities.

This document does not concern processes and capabilities of tools and methods for a single system but rather deals with those for a family of products.

2 Normative references

There are no normative references in this document.

3 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
binding
task to make a decision on relevant variants, which will be application assets, from *domain* (3.3) assets using the domain *variability* (3.7) model and from application assets using the application variability model

3.2
commonality
set of functional and non-functional characteristics that is shared by all applications belonging to the *product line* (3.4)

3.3
domain
distinct scope, within which common and variable characteristics are exhibited, common rules and *binding* (3.1) mechanisms are observed, and over which a distribution transparency is preserved

3.4
product line
product family
software and systems product line
set of products and/or services sharing explicitly defined and managed common and variable features and relying on the same *domain* (3.3) architecture to meet the common and variable needs of specific markets

3.5
product roadmap
schedule when the products have to be ready for market launch

3.6
technology roadmap
outline of required and anticipated changes in technologies, with expected dates, which will enable achievement or transformation of a product or *product family* (3.4)

3.7
variability
set of functional and non-functional characteristics that may differ among members of the *product line* (3.4)

4 Abbreviated terms

COTS component off-the-shelf

SSPL software and systems product line

5 Reference model for product line product management

5.1 Overview

The success of a product line depends on how well a product line management comprehends markets, technical trends and competitors' capability. Product management deals with the situation of markets, technical trends and competitors' capability, and defines a product family to deliver to markets. Product management should reflect the company's goals defined by top management. The company's objectives govern the whole decision made in product line product management. The initial product family definition shall be delivered to product line scoping for the detailed product family definition of a product line.

Product management provides strategic management for product families while organization management deals with managerial supports for implementing a successful product line. For this, product management is responsible for the economic and business concerns of product line engineering and management and the resulting product line(s). It deals particularly with the market strategy and the competitive strategy. Outcomes produced in product management are major inputs of organization management and product line scoping. Product management monitors markets, competitors and technical changes so as to cope proactively with market changes and new offerings from competitors, and to evolve product family continuously.

The reference model specifies the structure of product line-specific processes and subprocesses for product management. As shown in Figure 1, Product line product management can be structured into three processes: product management enablement, product management operation and product management support. In the rest of this document, tasks, methods and tools are described in terms of product line-specific processes and subprocesses defined in the reference model. Annex A describes key artefact flows between product management and other key roles of software and systems product line.

Each process is divided into subprocesses and each subprocess is described in terms of the following attributes:

— the title of the subprocess;

— the purpose of the subprocess;

— the inputs to produce the outcomes;

— the tasks to achieve the outcomes;

— the outcomes of the subprocess;

— the capabilities of methods and tools required for performing the tasks effectively and efficiently.

NOTE 1 When the process, subprocess, outcomes and tasks are listed or described in a sentence, they are italicized to get noticed.

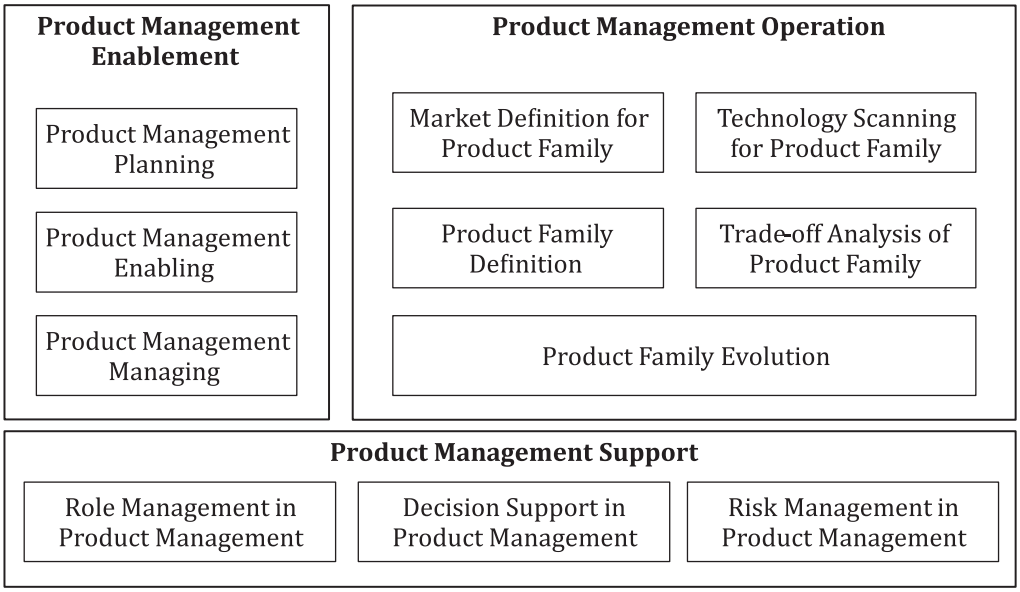

Figure 1 — Product line product management reference model

5.2 Product management enablement

The product management enablement shall serve to do the following and to define the capabilities of tools and methods for supporting them:

— *Product management planning* specifies how to monitor, measure and control the effectiveness of a product family. This subprocess also defines schedules and required resources for product management;

— *Product management enabling* establishes the governance policy for overall product management. This subprocess identifies the infrastructure and resource needs for product management operation and product management support, mobilizes qualified human resources for product management, enables quality assurance measurement for product management and improves product management process continuously;

— *Product management managing* monitors, measures and controls product management operation and product management support.

5.3 Product management operation

The product management operation shall serve to do the following and to define the capabilities of tools and methods for supporting them:

— *Market definition for product family* defines types of market segmentation for a product family, analyses competitors' profile and market opportunities for each market segment;

— *Technology scanning for product family* identifies and analyses key technologies for a product family so as to formulate the technology roadmap for product line product management;

— *Product family definition* identifies domains with initial product family member products, and thereafter analyses the high-level commonality and variability for the defining initial product family;

— *Trade-off analysis for product family* provides a formal way required for performing trade-off analysis for viable product family compositions. Vested stakeholders, key decision factors and ways to generate scenarios are addressed;

— *Product family evolution* achieves continuous evolution of a product family through monitoring changing trends in markets, technologies and competitiveness related to a product family. This subprocess includes tasks for evaluating evolution results and triggering follow-up actions.

5.4 Product management support

The product management support shall serve to do the following and to define the capabilities of tools and methods for supporting them:

— *Role management in product management* establishes and maintains roles and responsibilities for performing product management. Roles and responsibilities are monitored and controlled for improvement after they are identified, assigned and coordinated;

— *Decision support in product management* supports decision making concerning product line product management. Decision procedure, guidance for decision execution and assimilating lessons from decision results are dealt in this subprocess, and helps share decisions among relevant roles and responsibilities;

— *Risk management in product management* deals with risks for the platform and variability (e.g., business, technology, competitiveness) of a product family and develops a mitigation plan for the risks.

NOTE 2 This document is related to ISO/IEC/IEEE 15288 that is directly applicable to a single system. The processes and capabilities of methods and tools of this document correspond to the development of product families.

The identification and analysis of the key differentiators between single-system engineering and management and product line engineering and management can help organizations to understand the product line and to formulate a strategy for the successful implementation of product line engineering and management. The key aspects have been defined in ISO/IEC 26550 and Table 1 shows the category of the key aspects.

Table 1 — Key aspects for identifying product line-specific product management tasks

Category	Aspects
Reuse management	application engineering, domain assets, domain engineering, product management, platform, reusability
Variability management	binding, variability
Complexity management	collaboration, configuration, enabling technology support, reference architecture, texture, traceability
Quality management	measurement and tracking, cross functional verification and validation

The following are the descriptions for each aspect concerning product line product management. The product line product management relevant processes and tasks shall be identified on the basis of these aspects. The concerns specific to product line product management enable an organization to understand the product line product management relevant processes, subprocesses, tasks, methods and tools' capabilities:

— *Application engineering:* Product line product management defines a product family at the strategic level; thus, consisting member products that will be produced are decided by product management.

— *Binding:* Variability binding is an aspect that distinguishes product management of the product line development from that of the single product development.

— *Collaboration:* Stakeholders of product line product management include marketing experts, product managers, representative customers, domain experts, application experts and so on. Close collaborations among them are essential for the success of product management.

— *Configuration:* Configurations of assets for domain engineering and application engineering are distinguished aspects of the product line development. Maintaining integrity of assets is an important aspect. Configurations of products and artefacts of a product line can be multidimensional, i.e., exist in time and space.

— *Domain asset:* A platform consists of a collection of domain assets. Those domain assets may be tangible subsystems or components, or they may be engineering artefacts such as use cases, logical principles, architectural design patterns, etc. A product which is a member of a product family is engineered using domain assets specific but not necessarily unique to that product family. This is an aspect that distinguishes product management of the product line development from management of a single product development.

— *Domain engineering:* Domain engineering processes are product line-specific aspects that do not exist in the single product development.

— *Enabling technology support:* Enabling technologies for supporting efficient reuse and management of variability and assets distinguish from the single product development.

— *Measurement and tracking:* The performance of the product line processes should be measured aligning with the overall product line objectives. The measurement results should be collected, and they should be used to control product lines to achieve the business goals of the product family.

— *Platform:* Product line product management enables the development of a platform and the development of applications based on the platform.

— *Product management:* Product line product management should have the capability for defining and analysing the measures that make it possible to evaluate planned reusability and productivity and thereafter coordinate a product line towards achieving its business goals.

— *Reference architecture:* Reference architecture should be defined toward supporting the business goal achievement and the reusability. This is an aspect that distinguishes product management of the product line development from that of the single product development.

— *Reusability:* Product line product management monitors, evaluates and controls whether the desired level of reusability is achieved in a product family engineering endeavour. Providing managerial support for achieving desired level of reusability is a key aspect peculiar to product line development.

— *Texture:* Product line product management monitors and controls whether domain engineering and application engineering are following the rules defined in textures.

— *Traceability:* There exist trace links for business goal achievement, plan versus actual status, issue management, etc. in product line product management.

— *Cross functional validation and verification:* There exist cross functional assessments on business goal achievement, plan versus actual status, issue management, etc. in product line product management.

— *Variability:* Product line product management provides managerial capabilities for variability. Variability management is a distinguished aspect of product line development.

6 Product management enablement

6.1 General

Product management enablement supports the following subprocesses:

— *Product management planning*.

— *Product management enabling*.

— *Product management managing*.

6.2 Product management planning

6.2.1 Principal constituents

6.2.1.1 Purpose

The purpose of this subprocess is to analyse and establish product management needs and goals and define schedules and required resources for satisfying them.

6.2.1.2 Inputs

The following inputs should be available to perform the product management planning process:

— Product line goals (objectives).

— Existing product definition strategy used for a single product definition.

— Organizational level plans for a product line (from ISO/IEC 26556).

— Historical documents and data related to product family planning.

6.2.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the product management planning process:

— *Product management goal* is established.

— *Product definition strategy* is defined.

— *Product management plan, including key procedures, schedules and required resources and measures* is documented.

— *Changes of plans* are traced and maintained.

6.2.1.4 Tasks

The organization shall implement the following tasks with respect to the product management planning process:

— *Establish product management goals*: Define product management goals and strategies for offering such products that ensure the organization's continuous market leads.

— *Define key procedures for product management*: Tailor or define product management procedures and share the procedures with product management participants.

— *Define schedules and required resources for product management*: Schedule product management, including milestones and required resources.

— *Specify how to monitor, measure and control the effectiveness of product family*: Define ways to governing the monitoring, measuring and controlling of the effectiveness of a product family.

— *Document the product management plan*: Document and share the product management plans.

6.2.2 Establish product management goals

The goal of this task is to define product management goals and strategies for the successful achievement of organizational goals and for the provision of products that meet customer's needs on time.

The goal of product management is to contribute to the success of a product line organization by governing the product family endeavour as a whole.

The method should support establishing product management goals with the following capabilities:

— identifying the relationship between product management and product line goals;

— formulating product management goals;

— establishing the product definition strategy that describes how new products are defined.

A tool should support establishing product management goals by allowing the user to do the following:

— access product line goals and organizational level plans;

— communicate product management goals and strategies with key stakeholders by supporting channels and implemented mechanisms.

6.2.3 Define key procedures for product management

The goal of this task is to tailor and define product management procedures based on product line processes and to share the defined procedures with key stakeholders.

The method should support defining key procedures for product management with the following capabilities:

— tailoring procedures for product management based on the organizational product management process;

— defining decision-making procedures related to product management;

— defining integration and calibration procedures for product management;

— defining monitoring, measuring and controlling procedures for product management;

— defining procedures that guide the collaboration activities among key stakeholders of product management.

A tool should support defining key procedures for product management by allowing the user to do the following:

— access the existing procedures for product management;

— share key procedures with relevant key stakeholders;

— make decisions under the supports of decision-making procedures;

— integrate and calibrate procedures;

— document the defined procedures electronically.

6.2.4 Define schedules and required resources for product management

The goal of this task is to define schedules, milestones and resources for specifying a product roadmap based on the integrated information of market situation and technical trends, and for evolving a product roadmap in accordance with the changes on markets and technical trends.

The method should support defining schedules and required resources for product management with the following capabilities:

— understanding the organization's capability, procedures and roles/responsibilities to nurture product line in order to take the best decisions for product management schedules and resources;

— estimating and identifying possible resources for those needed;

— defining schedules and allocating resources for product management;

— identifying risk management items in product management.

A tool should support defining schedules and required resources for product management by allowing the user to do the following:

— (semi-)automate accessing information about organization's capability, procedures and roles/responsibilities to nurture product management;

— access an organization's available resources;

— define schedules and allocate resources for product management.

6.2.5 Specify how to monitor, measure and control the effectiveness of a product family

The goal of this task is to define procedures, measures and criteria for governing the monitoring, measuring and controlling of the effectiveness of a product family.

The method should support specifying how to monitor, measure and control the effectiveness of a product family with the following capabilities:

— defining observation points to monitor the effectiveness of a product family;

— defining measures and integration functions for integrating monitored results for evaluating the effectiveness of a product family;

— defining rules adhered when the product family is controlled.

A tool should support specifying how to monitor, measure and control the effectiveness of a product family by allowing the user to do the following:

— access history data related to product management;

— document the defined measures, procedures and criteria electronically;

— monitor actions (What, Who, Where, When, How) and collect the data;

— measure and analyse the effectiveness of a product family;

— control actions (What, Who, Where, When, How) and obtain feedback from the controls.

6.2.6 Document the product management plan

The goal of this task is to document the product management plan and obtain approvals for the product management plan.

The method should support documenting the product management plan with the following capabilities:

— providing a documentation template for the product management plans;

— formulating the product management plans;

— sharing product management plans with the corresponding users.

A tool should support documenting the product management plan by allowing the user to do the following:

— document the product management plan;

— share the product management plan with the relevant organization units and participants;

— use the mechanisms necessary for the planed versus actual analysis.

6.3 Product management enabling

6.3.1 Principal constituents

6.3.1.1 Purpose

The purpose of this subprocess is to identify and establish the infrastructure and resource required for product management governance, product management operation and product management support, including coordination with roles in a product family and continuous improvement capability of product management.

6.3.1.2 Inputs

The following inputs should be available to perform the product management enabling process:

— Market situations, technology trends and emerging best practices.

— Plans for product management, including key procedures, schedules and required resources.

— Current enabling capabilities and resources.

— Current improvement endeavours in enabling capabilities and resources.

6.3.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the product management enabling process:

— *Governance policy for product management* is clarified.

— *Roles and responsibilities for product management* are structured.

— *Product management enablers and resources* are deployed.

— *Product management processes* are continuously improved.

6.3.1.4 Tasks

The organization shall implement the following tasks with respect to the product management enabling process:

— *Establish governance policy for product management*: Define policies that govern the overall product management activities and artefacts.

— *Mobilize qualified human resources for product management*: Organize required capabilities and qualifications sufficient to carry out activities and tasks of product management operation and supports.

— *Identify infrastructure and resource needs for product management operation and product management support*: Develop capabilities, qualifications and resources that enable product management.

— *Enable quality assurance measurement for product management*: Activate quality assurance in product management for ensuring adherence of defined procedures, rules and constraints.

— *Improve product management process continuously*: Examine gaps between deployed and required enablers, so as to provide improved enablers.

6.3.2 Establish governance policy for end-to-end product lifecycle

The goal of this task is to clarify policies regarding the formation of overall rules and guides for product management. The governance policy describes the principles and practices that guide the participants and stakeholders of product management in carrying out their roles and responsibilities.

The governance policy for product management should be designed to effectively supervise the product family operation and to ensure the oversight mechanisms and procedures in which the product family is governed. The policies are reviewed on an annual basis in the context of changing market situations, technology trends and emerging best practices with a view to enhancing the governance of the product family.

NOTE 1 ISO/IEC 38500 provides principles for IT Governance.

The method should support establishing the governance policy for product management with the following capabilities:

— providing oversight mechanisms and procedures for effectively supervising the activities and tasks of product management operation and support;

— guiding governance policy improvements according to changing market situations, technology trends and emerging best practices;

— defining a way of monitoring the effectiveness of the governance policy.

A tool should support establishing the governance policy for product management by allowing the user to do the following:

— document the governance policy for product management;

— share the governance policy with the relevant organization units and participants;

— monitor the status of governance policy adherence;

— identify the gaps between governance policies and actual practices.

6.3.3 Mobilize qualified human resources for end-to-end product lifecycle

The goal of this task is to define required capabilities and qualifications for carrying out activities and tasks of product management operation and support and to mobilize qualified human resources for product management.

The method should support mobilizing qualified human resources for executing product management with the following capabilities:

— defining required qualifications for product management;

— aligning the required qualifications for product management in accordance with the product line organizational structure and the defined product management procedures;

— defining evaluation criteria for the selection of qualified human resources for product management;

— mobilizing qualified human resources for carrying out activities and tasks of product management operation and support.

A tool should support mobilizing qualified human resources for executing product management by allowing the user to do the following:

— archive historical and current required qualifications of product management;

— align the required qualifications for product management in accordance with the product line organizational structure and the defined product management procedures through the communication channel;

— document the evaluation criteria for the selection of qualified human resources for product management, which can be utilized during the selection process.

6.3.4 Identify infrastructure and resource needs for end-to-end product lifecycle

The goal of this task is to develop and establish capabilities and resources that leverage for achieving product management goals.

The method should support identifying the infrastructure and resource needs for product management operation and support with the following capabilities:

— understanding the organization's capability, procedures and roles/responsibilities to nurture product management operation and support;

— estimating and identifying the needed infrastructure and resources;

— assigning the infrastructure and resources for product management operation and support.

A tool should support identifying the infrastructure and resource needs for product management operation and support by allowing the user to do the following:

— access the information of the organization's capability, procedures and roles/responsibilities;

— estimate and identify the needed infrastructure and resources by providing historical data on the infrastructure and resources;

— document the required infrastructure and resources.

6.3.5 Enable quality assurance measurement for end-to-end product lifecycle

The goal of this task is to define actionable tasks related to goal setting, policy setting, managerial support, guide, measurement, assurance, feedback and close for effective and efficient enabling of quality assurance in product management.

The method should support enabling quality assurance measurement for product management with the following capabilities:

— defining actionable tasks for the effective and efficient enabling of quality assurance in product management;

— providing mechanisms and procedures for effective quality assurance measurement in product management;

— identifying resolutions to mitigate conflicts between quality assurance activities and other roles in product management;

— providing quality assurance measurement results for product management to relevant stakeholders and corporate management;

A tool should support enabling quality assurance measurement for product management with the following capabilities:

— access best practices of quality assurance in product management;

— accumulate raw data collected during the quality assurance measurement for product management;

— use communication channels and implemented mechanisms for sharing quality assurance artefacts.

6.3.6 Improve product management process continuously

The goal of this task is to examine gaps between deployed and required enablers and to provide the improved enablers.

The method should support improving product management process continuously with the following capabilities:

— collecting data for evaluating the effectiveness of product management;

— analysing deviations from the required performance/capability of product management necessary to achieve the established product management goals;

— establishing action plans and success measures on improvement activities for achieving product management goals;

— controlling and tracing the status of improvement activities to closure.

A tool should support improving product management process continuously by allowing the user to do the following:

— accumulate data related to the improvement of product management process;

— visualize deviation between the actual and expected effectiveness of product management;

— share improvement activities with relevant participants through the communication channels and implemented mechanisms;

— check the status of improvement activities.

6.4 Product management managing

6.4.1 Principal constituents

6.4.1.1 Purpose

The purpose of this subprocess is to monitor, measure and control product management operation and product management support.

6.4.1.2 Inputs

The following inputs should be available to perform the product management managing process:

— Outcomes of product family planning.

— Outcomes of product family enabling.

— Outcomes of risk management plan in product management.

— Actual operation progresses and results of product management.

— Actual support progresses and results of product management.

6.4.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the product management managing process:

— *Monitor or control results for product management operation and support* are accessible.

— *Deviations in actual operation of product management from plans* are managed.

— *Deviations in actual support of product management from plans* are managed.

— *Identified risks in product management* are mitigated or managed.

— *Feedback to planning and enabling function of product management* is provided to relevant stakeholders.

6.4.1.4 Tasks

The organization shall implement the following tasks with respect to the product management managing process:

— *Tailor and allocate governance policy, R & R and resources to relevant sub functions of product management*: Coordinate the governance policy, R & R and resources to relevant functions of product management.

— *Collect data from product management sub functions*: Gather evidences of product management execution from all sub functions.

— *Monitor, measure and control product management operation and product management support*: Define and activate procedures, measures and criteria for monitoring, measuring and controlling the deviations in product management.

— *Manage actual operation and support of product management*: Resolve deviations from the planned product management operation and support.

— *Provide feedback to planning and enabling functions of product management*: Give constructive feedback to planning and enabling functions of product management.

6.4.2 Tailor and allocate governance policy, R & R and resources to relevant sub functions of product management

The goal of this task is to assign roles, responsibilities and required resources to relevant functions of product management together with relevant rules and guides.

The method should support tailoring and allocating the governance policy, R & R and resources to relevant sub functions of product management with the following capabilities:

— identifying detailed circumstances for managing a product family;

— tailoring rules and guides of the governance policy in order to adjust them to the detailed *circumstances*;

— mapping R&Rs (Roles and Responsibilities) and resources to relevant sub functions of product management;

— adjusting insufficient or surplus R&Rs and resources.

A tool should support tailoring and allocating the governance policy, R & R and resources to relevant sub functions of product management by allowing the user to do the following:

— access the defined governance policy, R&R and resources for product family management;

— generate matrix from R&Rs and resources to relevant sub functions of product management;

— adjust insufficient or surplus R&Rs and resources.

6.4.3 Collect data from product management sub functions

The goal of this task is to gather evidences of product management from all sub functions regarding defined monitors, measures and controls for the effectiveness of a product family.

The method should support collecting data from product management sub functions with the following capabilities:

— determining targeted variables from product management sub functions;

— defining mechanisms for data collection from product management sub functions;

— storing the collected data to permanent or temporary storage;

— categorizing and/or organizing the collected data.

A tool should support collecting data from product management sub functions by allowing the user to do the following:

— collect data from product management sub functions using data collection mechanisms;

— store the collected data to permanent or temporary storage;

— categorize and/or organize the collected data.

6.4.4 Monitor, measure and control product management operation and support

The goal of this task is to define procedures, measures and criteria for control for monitoring, measuring and controlling the product management operation and support.

The method should support monitoring, measuring, and controlling product management operation and support with the following capabilities:

— Defining measures, metrics and measurement points in the procedures of product management operation and support;

— defining information essential to confirm the effectiveness of product management operation and support;

— defining integration/characterization functions for integrating monitored results for evaluating the effectiveness of product management operation and support;

— identifying thresholds and decision alternatives in controlling product management operation and support;

— building up knowledge related to controlling product management operation and support.

A tool should support monitoring, measuring and controlling product management operation and support by allowing the user to do the following:

— integrate monitored and measured results using supporting mechanisms;

— (semi-)automate the calculation for the defined integration functions or characterisation functions;

— derive knowledge from the measured results;

— visualize/represent thresholds and decision alternatives in controlling product management operation and support.

6.4.5 Manage actual operation and support of product management

The goal of this task is to compare the planned versus actual operation and support of product management, so as to specify required actions to improve the operation and support of product management.

The method should support managing the actual operation and support of product management with the following capabilities:

— establishing the expected performance of product management operation and support;

— comparing the planned versus actual operation and support results of product management;

— analysing root causes of the gaps;

— deriving improvement needs and action items for the operation and support of product management.

A tool should support managing the actual operation and support of product management by allowing the user to do the following:

— compare the planned versus actual operation and support results of product management;

— analyse root causes of the gaps;

— share improvement action items using communication channels and implemented mechanisms.

6.4.6 Provide feedback to planning and enabling functions of product management

The goal of this task is to give constructive feedback to planning and enabling functions of product management, so that corresponding participants develop improved plans and effective enabling capabilities.

The method should support providing feedback to planning and enabling functions of product management with the following capabilities:

— integrating lessons learned during product managing;

— analysing the rationale for improving the planning and enabling functions of product management;

— defining mechanisms for propagating feedback to distributed and different product line organization units;

— delivering feedback to the right planning and enabling functions of product management.

A tool should support providing feedback to planning and enabling functions of product management by allowing the user to do the following:

— integrate lessons learned during product managing;

— propagate feedback to relevant product line organization units;

— store lessons learned into the permanent storage for the further use.

7 Product management operation

7.1 General

Product management operation supports the following subprocesses:

— *Market definition for product family.*

— *Technology scanning for product family.*

— *Product family definition.*

— *Trade-off analysis of product family.*

— *Product family evolution.*

7.2 Market definition for product family

7.2.1 Principal constituents

7.2.1.1 Purpose

The purpose of this subprocess is to define types of market segmentation for a product family, to compile the voice of customers for each market segment, to forecast trends in sales for each market segment, to analyse competitors' profile for each market segment, to analyse market opportunities for each market segment, to simulate potential new or refined member products for each market segment, to analyse strategic-level commonalities (platform) and variabilities and to communicate and share the market definition results.

7.2.1.2 Inputs

The following inputs should be available to perform the market definition for the product family process:

— Product line goals (objectives).

— Market segments of a single product or previous SSPL.

— Competitors' profile of a single product or previous SSPL.

— Historical trends in sales for each market segment.

— Market opportunities of a single product or previous SSPL.

7.2.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the market definition for the product family process:

— *Market segments for a product family* are defined.

— *Voice of customers for each market segment* are compiled.

— *Competitors' profile for each market segment* is defined.

— *Trends in sales for each market segment* are forecasted.

— *Market opportunities for each market segment* are defined.

— *Potential new or refined member products for each market segment* are simulated to realize the defined market opportunities.

— *Strategic-level commonalities (platform) and variabilities for each market segment* are analysed.

— *Scenarios for business goal achievement* are simulated.

— *Market definition results* are documented and shared.

7.2.1.4 Tasks

The organization shall implement the following tasks with respect to the market definition for the product family process:

— *Define types of market segmentation for a product family*: Classify markets for deciding product family members, including their major features and quality attributes.

— *Compile the voice of customers for each market segment*: Capture and integrate the needs and demands from representative customers for each market segment to decide the best product family members, features and quality attributes.

— *Analyse competitors' profile for each market segment*: Analyse what makes the competitors successful.

— *Forecast trends in sales for each market segment*: Predict future trends of sales in each defined market segment for deciding the best product family members, features and quality attributes.

— *Analyse market opportunities for each market segment*: Identify unmet needs, wants and demands that are not being addressed by the competitors.

— *Document market definition results*: Define and document the target markets for the product family and its member products.

7.2.2 Define types of market segmentation for a product family

The goal of this task is to classify markets in accordance with customers' wants, needs and demands for deciding product family members, including their major features and quality attributes.

The method should support defining types of market segmentation for a product family with the following capabilities:

— developing product differentiation strategies for a product family;

— dividing target markets broadly for a product family;

— defining specific demands and attributes of market segments;

— comparing with competitors' strategy for market segments;

— analysing the voice of customers related to market segments.

A tool should support defining types of market segmentation for a product family by allowing the user to do the following:

— integrate information across different market segmentation of products;

— access customer representatives aggregated by similar products or aggregated from the product family perspectives;

— display dashboards for online viewing of alternative market segmentation;

— analyse the voice of customers related to market segments.

7.2.3 Compile the voice of customers for each market segment

The goal of this task is to capture the wants, needs and demands from the customers of each market segment to decide the best product family members and features.

The method should support compiling the voice of customers for each market segment with the following capabilities:

— defining questionnaires for listening the voice of customers in each market segment;

— making plans on how to distribute and receive feedback from customers;

— compiling the voice of customers for each market segment;

— analysing the voice of customers for each market segment of a product family.

A tool should support compiling the voice of customers for each market segment by allowing the user to do the following:

— categorize questionnaire distributions, collect responses and aggregate the responses by customer segments and types of products of a product family;

— analyse the aggregated voice of customers in different market segments and types of products of a product family;

— compile the voice of customers for each market segment.

7.2.4 Analyse competitors' profile for each market segment

The goal of this task is to analyse what makes the competitors successful. Key competitors in each market segment should be analysed.

The method should support analysing competitors' profile for each market segment with the following capabilities:

— analysing key success factors of competitors in market segment;

— performing SWOT (strength, weakness, opportunity, threat) analysis against competitors' capability;

— integrating findings of key success factors of competitors' in all market segments.

A tool should support analysing competitors' profile for each market segment by allowing the user to do the following:

— analyse the key success factors of competitors' in market segments related to a product family;

— perform the SWOT analysis for a product family;

— document the findings obtained from the key success factors of competitors' in all market segments related to a product family.

7.2.5 Forecast trends in sales for each market segment

The goal of this task is to find future trends of sales in each market segment based on the current sales trends of a company and competitors, and the analysis results of voice of customers.

The method should support forecasting trends in sales for each market segment with the following capabilities:

— integrating existing sales data for member products and a product family;

— exercising sales forecasts based on organizational practices of forecasting;

— providing sales forecasts for a product family.

A tool should support forecasting trends in sales for each market segment by allowing the user to do the following:

— integrate data for sales forecasts;

— forecast sales using COTS package software.

7.2.6 Analyse market opportunities for each market segment

The goal of this task is to identify unmet or new needs, wants and demands that are not being addressed by the competitors.

The method should support analysing market opportunities for each market segment with the following capabilities:

— identifying unmet or new market needs and demands that a company can exploit because they are not being addressed for certain market segment(s);

— identifying viable markets by employing product family perspectives.

A tool should support analysing market opportunities for each market segment by allowing the user to do the following:

— evaluate unmet or new market needs and demands;

— identify viable markets by employing product family perspectives including platform and variability.

7.2.7 Document market definition results

The goal of this task is to define and document the target markets for a product family and its member products.

The method should support documenting market definition results with the following capabilities:

— providing a documentation template for market definition results;

— providing the rationale of the market definition;

— identifying viable target markets for a product family and its member products;

— sharing the market definition results with the relevant stakeholders.

A tool should support documenting market definition results by allowing the user to do the following:

— document market definition results in accordance with the documentation template;

— communicate the market definition results with relevant stakeholders;

— maintain the market definition results.

7.3 Technology scanning for product family

7.3.1 Principal constituents

7.3.1.1 Purpose

The purpose of this subprocess is to identify and analyse key technologies for a product family, to analyse competitors' profile of key technologies, to forecast trends in emerging key technologies, to analyse strategic-level commonalities (platform) and variabilities related to technology trends, to simulate scenarios for business goal achievement by utilizing technology leverages, and so as to formulate a technology roadmap for product line product management.

7.3.1.2 Inputs

The following inputs should be available to perform the technology scanning for the product family process:

— Technologies related to existing member products of a product family or previous product family.

— Competitors' position in key technologies related to a product family.

— 3rd party analysis results on technology trends including emerging technologies that are relevant to a product family.

— SSPL technology trends and international standards.

7.3.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the technology scanning for the product family process:

— *Key technologies, including their impacts for a product family* are defined.

— *Competitors' profile of key technologies* is analysed.

— *Trends in emerging key technologies* are forecasted.

— *Strategic-level commonalities (platform) and variabilities related to technology trends* are analysed.

— *Scenarios for business goal achievement by utilizing technology leverages* are simulated.

— *Technology roadmap for a product family* is documented and shared.

7.3.1.4 Tasks

The organization shall implement the following tasks with respect to the technology scanning for the product family process:

— *Identify key technology for product family*: Define key technologies that can leverage the success of a product family.

— *Analyse technology impacts on product family*: Specify positive and negative impacts of defined key technologies on a product family.

— *Analyse competitors' profile of key technology*: Identify key technologies that lead competitors to success in markets.

— *Forecast evolution trends in key technology*: Predict future trends of key technologies that enhance an organization's competitive edge through a product family.

— *Evaluate strategic alternatives for competitiveness through key technology*: Define and evaluate alternatives of key technologies to determine such a set of key technologies that enable the competitiveness of an organization for a long period.

— *Formulate technology roadmap for product family*: Establish a technology roadmap that will be implemented with an evolution of a product family.

7.3.2 Identify key technology for product family

The goal of this task is to identify key technologies that can leverage a product family to success. Key technologies might contribute to differentiate a member product and/or overall product family in its markets and might improve the efficiency and/or effectiveness of the development, operation and maintenance of member products and the product family.

The method should support identifying key technology for a product family with the following capabilities:

— classifying key technologies of existing products of a product family;

— identifying emerging and future technologies for a product family;

— categorizing technologies in accordance with their changing trends;

— documenting and maintaining the pool of identified key technologies.

A tool should support identifying key technology for a product family by allowing the user to do the following:

— utilize the integrated channel across relevant stakeholders of a product family;

— document and maintain the pool of identified key technologies;

— access the pool of identified key technologies.

7.3.3 Analyse technology impacts on product family

The goal of this task is to specify impacts on a product family that could be originated by the defined key technologies. The impacts might not only be positive but also be negative on a product family.

The method should support analysing technology impacts on a product family with the following capabilities:

— mapping technologies to member products of a product family;

— analysing potential cannibalization effects among member products due to technologies;

— analysing whether products of a product family are differentiated with each other by technologies;

— valuating the technology impacts on a product family.

A tool should support analysing technology impacts on a product family by allowing the user to do the following:

— check dashboards as indicators used as a measure to gain further insights into the technology trends;

— align short-term, mid-term and long-term vision of a product family with technologies;

— valuate the technology impacts on a product family.

7.3.4 Analyse competitors' profile of key technology

The goal of this task is to analyse current technological status and future potentials in key technologies, which are relevant to a product family, of competitors in target markets.

The method should support analysing competitors' profile of key technology with the following capabilities:

— analysing SWOT (strength, weakness, opportunity, threat) of competitors' key technologies;

— integrating findings on different competitors for each market segment;

— analysing current and future gaps in key technologies based on competitors' profile.

A tool should support analysing competitors' profile of key technology by allowing the user to do the following:

— perform a multi-criteria analysis on competitors' technology profile in regard to a product family;

— integrate competitors' profile by types of products of a product family;

— maintain and share competitors' profile.

7.3.5 Forecast evolution trends in key technology

The goal of this task is to forecast future trends in key technology that enhance competitive edge of a product family.

Existing methods of technology forecasting include Delphi method, forecast by analogy, growth curves and extrapolation.

The method should support the forecasting of evolution trends in key technology with the following capabilities:

— organizing expert group(s) who are capable of technology forecasting for a product family;

— analysing the past performance of technology forecasting in key technologies;

— selecting methodology (e.g., Delphi, forecast by analogy, growth curves, extrapolation, etc.) of technology forecasting for a product family;

— exercising (multiple) technology forecasting in key technologies;

— combining forecasting results and improving inconsistencies among the results.

A tool should support the forecasting of evolution trends in key technology by allowing the user to do the following:

— check dashboards as indicators used as a measure to gain further insight into the emerging technologies;

— check past performance of technology forecasting in key technologies;

— execute methodology (e.g., Delphi, forecast by analogy, growth curves, extrapolation, etc.) of technology forecasting for a product family;

— combine and maintain the forecasting results.

7.3.6 Evaluate strategic alternatives for competitiveness through key technology

The goal of this task is to evaluate key technologies to determine which key technology possesses strategic impact, such that a company can surpass its competitors for a long period.

The method should support evaluating strategic alternatives for competitiveness through key technology with the following capabilities:

— evaluating technology forecasting results from the integrated product family perspectives;

— analysing alternatives including valuation for enhancing competiveness of a product family;

— prioritizing and selecting among strategic alternatives;

— aligning the selected alternative with markets of a product family.

A tool should support evaluating strategic alternatives for competitiveness through key technology by allowing the user to do the following:

— analyse and valuate key technologies with their impacts on markets;

— prioritize and select key technologies;

— maintain the evaluation results.

7.3.7 Formulate technology roadmap for product family

The goal of this task is to establish a roadmap that matches short-term, mid-term and long-term goals of a product line organization with differentiated key technologies.

The method should support formulating technology roadmap for a product family with the following capabilities:

— summarizing technology trends for a product family;

— applying life-cycle stage (e.g. introduction, growth, maturing, and so on) of technology for each member product;

— defining technology roadmap for short-term, mid-term and long-term;

— providing rationale for this formulation.

A tool should support formulating technology roadmap for a product family by allowing the user to do the following:

— document and maintain technology roadmap;

— communicate and access the technology roadmap.

7.4 Product family definition

7.4.1 Principal constituents

7.4.1.1 Purpose

The purpose of this subprocess is to identify domain with possible product family member products, and thereafter to analyse high-level commonality and variability for defining the initial product family.

7.4.1.2 Inputs

The following inputs should be available to perform the product family definition process:

— Product line goals (objectives).

— Market segments.

— List of products currently on offer.

— Competitors' profile.

— Voice of customers for each market segment.

— Technology roadmap.

— Market opportunities.

7.4.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the product family definition process:

— *Candidate members of product family are analysed.*

— *Functional and non-functional characteristics of potential product family members are analysed.*

— *High-level domain with high-level commonality and variability is identified.*

— *Initial product family is defined and documented.*

7.4.1.4 Tasks

The organization shall implement the following tasks with respect to the product family definition process:

— *Identify high-level domain*: Decide which features will be in and which will be out from a product family at the highest level.

— *Identify initial candidate members of product family*: Select initial product family members based on products currently on offer, and add new products based on emerging markets and technologies.

— *Define initial functional and non-functional characteristics of product family*: Specify an initial list of functional and non-functional characteristics of a product family.

— *Analyse high-level commonality*: Find out common functional and non-functional characteristics among those of initial candidate product family members.

— *Analyse high-level variability*: Find out variable functional and non-functional characteristics among those of initial candidate product family members.

— *Document initial product family*: Specify an initial product family with its common and variable functional and non-functional characteristics.

7.4.2 Identify high-level domain

The goal of this task is to decide which features will be in and which will be out from a product family. The boundary of a high-level domain is decided.

The method should support identifying high-level domain with the following capabilities:

— analysing market needs and demands for determining which feature will be in or out of a domain;

— analysing key technologies for determining which feature will be in or out of a domain;

— analysing features of existing products for determining which feature will be in or out of a domain;

— identifying potential products that do not exist but relevant to market needs or key technologies.

A tool should support identifying high-level domain by allowing the user to do the following:

— access information related to identified market needs, key technologies and existing products;

— visualize the progress for determining the boundary of a domain.

7.4.3 Identify initial candidate members of product family

The goal of this task is to choose initial product family members based on products currently on offer, market definition and technology roadmap.

The method should support identifying initial candidate members of a product family with the following capabilities:

— selecting existing products as initial candidate members of a product family;

— defining new member products of a product family;

— improving and/or refining existing member products of a product family;

— producing an initial product family map.

A tool should support identifying initial candidate members of a product family by allowing the user to do the following:

— access the information of existing products;

— visualize the progress of determining initial candidate members of a product family;

— represent mapping results of product candidates to the defined domain.

7.4.4 Define initial functional and non-functional characteristics of product family

The goal of this task is to specify an initial list of functional and non-functional characteristics of a product family.

The method should support defining initial functional and non-functional characteristics of a product family with the following capabilities:

— converting market needs and demands into initial functional and non-functional characteristics of a product family;

— converting key technologies into initial functional and non-functional characteristics of a product family;

— adding existing functional and non-functional characteristics to a product family.

A tool should support defining initial functional and non-functional characteristics of a product family by allowing the user to do the following:

— access identified market needs and key technologies;

— list-up the identified characteristics for reviewing functional and non-functional characteristics of a product family;

— produce explicit products and characteristics matrix for the further analysis.

7.4.5 Analyse high-level commonality

The goal of this task is to identify common functional and non-functional characteristics by mapping them to initial candidate product family members.

The method should support analysing high-level commonality with the following capabilities:

— classifying identified functional characteristics to commonality;

— classifying identified non-functional characteristics to commonality;

— characterizing high-level commonality (e.g. costs and benefits functions);

— characterizing commonalities regarding the total life-cycle of the product line.

A tool should support analysing high-level commonality by allowing the user to do the following:

— perform automated analysis of costs, benefits and characteristics functions for characterizing high-level commonality;

— represent the characteristics of high-level commonality for reviewing and reference.

7.4.6 Analyse high-level variability

The goal of this task is to identify variable functional and non-functional characteristics by mapping them to initial candidate product family members.

The method should support analysing high-level variability with the following capabilities:

— classifying identified functional characteristics to variability;

— classifying identified non-functional characteristics to variability;

— characterizing high-level variability (e.g. functions for evaluating costs for making it reusable, benefits through reuse).

A tool should support analysing high-level variability by allowing the user to do the following:

— perform automated analysis of costs, benefits and characteristics functions for characterizing high-level variability;

— represent the characteristics of high-level variability for reviewing and reference.

7.4.7 Document initial product family

The goal of this task is to specify an initial product family with a list of common or variable functional and non-functional characteristics, including rationales for the decision.

The method should support documenting the initial product family with the following capabilities:

— Integrating results of product family definition;

— providing a documentation template for the initial product family;

— documenting the initial product family;

— maintaining the documented initial product family.

A tool should support documenting the initial product family by allowing the user to do the following:

— document the initial product family in accordance with the documentation template;

— share the documented initial product family;

— maintain the documented initial product family.

7.5 Trade-off analysis for product family

7.5.1 Principal constituents

7.5.1.1 Purpose

The purpose of this subprocess is to provide a formal way required for performing trade-off analysis for viable product family compositions. Trade-off analysis can be frequently performed in software and systems product line. Annex B provides exemplary trade-off analysis method.

7.5.1.2 Inputs

The following inputs should be available to perform the trade-off analysis for the product family process:

— Product line goals (objectives).

— Market segments.

— Competitors' profile.

— Technology roadmap.

— Voice of customers.

— Market opportunities.

— List of products currently on offer.

— Functional and non-functional characteristics of potential product family members.

— High-level commonality and variability of potential product family members.

— Initial product family definition.

7.5.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the trade-off analysis for the product family process:

— *Scenarios for trade-off analysis of product family* are documented.

— *Trade-off analysis results of product family* are documented.

— *Scenarios for business goal achievement* are defined.

— *Market segments for product family* are defined.

— *Sales for each market segment* are forecasted.

— *Product family definition results* are documented and shared.

7.5.1.4 Tasks

The organization shall implement the following tasks with respect to the trade-off analysis for the product family process:

— *Formulate the trade-off analysis team*: Establish a team that consists of members who perform trade-off analysis for an initial product family.

— *Identify vested stakeholders*: Find a group of key stakeholders who have extensive domain knowledge with practical experiences.

— *Identify key decision factors and criteria for viable product family*: Define factors and criteria to be used for trade-off analysis for an initial product family.

— *Perform trade-off analysis using scenarios*: Determine viable product family based on trade-off analysis results.

— *Document trade-off analysis results of product family*: Specify trade-off analysis results and deliver them to downstream users.

7.5.2 Formulate the trade-off analysis team

The goal of this task is to establish a team for performing trade-off analysis for initial product family definition.

The method should support formulating the trade-off analysis team with the following capabilities:

— defining and accepting a set of common goals on performing trade-off analysis for initial product family definition;

— defining goals to be specific, measurable, challenging, and tractable (e.g., be visible how they are progressing towards goals);

— identifying clear scope, tasks and roles of the team members;

— providing necessary environments and resources for performing trade-off analysis;

— selecting team members who know what to do, how to do it, when to do it and when they are finished on performing trade-off analysis for initial product family definition.

A tool should support formulating the trade-off analysis team by allowing the user to do the following:

— access the structure of organization units or functions of a product line;

— perform trade-off analysis through the provided communication channels and mechanisms.

7.5.3 Identify vested stakeholders

The goal of this task is to find a group of key stakeholders who possess strategic, managerial, technical or methodological domain knowledge with practical experiences on trade-off analysis and/or initial product family definition.

The method should support identifying vested stakeholders with the following capabilities:

— analysing stakeholder roles, interest and influences;

— identifying stakeholders who have a vested interest in the outcomes of product family definition;

— consolidating stakeholder information (e.g. their influences) for determining vested stakeholders;

— determining a way to vested stakeholder engagement.

A tool should support identifying vested stakeholders by allowing the user to do the following:

— access the information necessary for relevant stakeholders;

— utilize communication channels and mechanisms necessary for the trade-off analysis.

7.5.4 Identify key decision factors and criteria for viable product family

The goal of this task is to define factors and criteria to be used for evaluating an initial product family. Factors and criteria are used for determining expected values obtained through the product family and their functional and non-functional characteristics.

The method should support identifying key decision factors and criteria for a viable product family with the following capabilities:

— determining decision goal, strategy, process and outcome for a viable product family;

— identifying key decision factors and criteria for a viable product family;

— providing value metrics for the identified decision criteria;

— providing value consolidation mechanisms for the multi criteria decision on a viable product family.

A tool should support identifying key decision factors and criteria for a viable product family by allowing the user to do the following:

— share key decision factors and criteria for a viable product family with relevant stakeholders;

— identify a viable product family through multi-criteria decision support mechanisms.

7.5.5 Perform trade-off analysis using scenarios

The goal of this task is to use scenarios for performing trade-off analysis, so as to determine a viable product family by performing trade-off analysis.

The method should support generating scenarios to be evaluated for a viable product family with the following capabilities:

— generating alternative scenarios to be evaluated for determining a viable product family;

— converging alternative scenarios to be evaluated for determining a viable product family;

— assigning value measures for the identified decision criteria to perform trade-off analysis against the scenarios;

— assessing consolidated values for the multi criteria decision on a viable product family;

— selecting the best alternatives for a viable product family;

— reviewing the gaps between expected and actual results on a viable product family;

— analysing root cause of the gaps;

— documenting lessons learned from trade-off analysis.

A tool should support generating scenarios to be evaluated for a viable product family by allowing the user to do the following:

— visualize a decision matrix;

— determine the values of each criteria;

— evaluate a viable product family through multi-criteria decision support mechanisms.

7.5.6 Document trade-off analysis results of product family

The goal of this task is to recode trade-off analysis results and deliver them to downstream users for further decision of a product family.

The method should support documenting trade-off analysis results of a product family with the following capabilities:

— providing a documentation template for trade-off analysis results of a product family;

— documenting trade-off analysis results of a product family;

— sharing the decision rationale with relevant stakeholders.

A tool should support documenting trade-off analysis results of a product family by allowing the user to do the following:

— document the trade-off analysis results of a product family;

— share the trade-off analysis results through communication channels.

7.6 Product family evolution

7.6.1 Principal constituents

7.6.1.1 Purpose

The purpose of this subprocess is to achieve the continuous evolution of a product family by monitoring changing trends in markets, technologies and competitiveness related to a product family. Product family evolution as a directed strategic initiative considers the relationship between current or predicted market forces and trends, and capability-related strategic decisions (including internal and supply chain partner capabilities, resources, technologies as well as dynamic capabilities). Evolution results are evaluated for the follow-up actions.

7.6.1.2 Inputs

The following inputs should be available to perform the product family evolution process:

— Product line goals (objectives).

— Market segments.

— Competitors' profile.

— Technology roadmap.

— Voice of customers.

— Market opportunities.

— List of products currently on offer.

— Functional and non-functional characteristics of potential product family members.

— High-level commonality and variability of potential product family members.

— Product family definition.

— Changing trends of business, technology and competitiveness of a product family.

— Product family evolution process.

— Actual results of the execution of the previous product family evolution.

7.6.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the product family evolution process:

— *Scenarios for trade-off analysis of the product family evolution* are documented.

— *Trade-off analysis results of the product family evolution* are documented.

— *Scenarios for business goal achievement* are defined.

— *Market segments for a product family* are refined.

— *Sales for the market segment(s) that are related to the product family evolution* are forecasted.

— *Refined product family definition results* are documented and shared.

— *The initiation decision of a product family evolution process* is triggered.

— *Follow-up actions* are triggered.

— *Lessons learned* are documented.

7.6.1.4 Tasks

The organization shall implement the following tasks with respect to the product family evolution process:

— *Monitor changing trends of business, technology and competitiveness of a product family*: Capture changes on business, technology and competitors, so as not to fall behind in the competition.

— *Trigger the initiation decision of a product family evolution process*: Decide whether evolving a product family starts or not in accordance with the changing trends.

— *Monitor the progress of the product family evolution process*: Check the status of product family evolution, so as to control deviations from plans.

— *Evaluate the result of the product family evolution*: Ensure that the product family evolution achieves its evolution goals.

7.6.2 Monitor changing trends of business, technology and competitiveness of product family

The goal of this task is to capture current and expected changes on business, technology and competitors' profiles for improving a product family, so as not to fall behind in the competition.

The method should support monitoring changing trends of business, technology and competitiveness of a product family with the following capabilities:

— monitoring data of changing trends of business, technology and competitiveness of a product family;

— analysing changing trends of business, technology and competitiveness of a product family over time and space;

— verifying whether the threshold condition for triggering the initiation decision of a product family evolution process is reached;

— documenting the scenarios for trade-off analysis of product family evolution if the threshold condition for triggering the initiation decision of a product family evolution process is reached.

A tool should support monitoring changing trends of business, technology and competitiveness of a product family by allowing the user to do the following:

— access data of changing business, technology and competitiveness trends of a product family;

— visualize the warning and tipping points of changing environments;

— document the scenarios for trade-off analysis of product family evolution.

7.6.3 Trigger the initiation decision of a product family evolution process

The goal of this task is to initiate a product family evolution process in accordance with the monitored changing trends.

The method should support triggering the initiation decision of a product family evolution process with the following capabilities:

— devising change initiatives for product family evolution;

— provisioning plans for product family evolution;

— converging alternative scenarios that will be evaluated for determining product family evolution;

— assigning value measures for the identified decision criteria to perform trade-off analysis against the scenarios;

— assessing consolidated values for the multi criteria decision on product family evolution;

— selecting the best alternatives for product family evolution;

— supporting traceable product family evolution.

A tool should support triggering the initiation decision of a product family evolution process by allowing the user to do the following:

— visualize a decision matrix;

— determine the values of each criterium;

— decide the initiation of a product family evolution process through multi-criteria decision support mechanisms;

— perform automated tracing among the different product family versions.

7.6.4 Monitor the progress of the product family evolution process

The goal of this task is to monitor and measure the status of product family evolution, so as to draw gaps between the plan versus the actual product family evolution process.

The method should support monitoring the progress of the product family evolution process with the following capabilities:

— supporting enablers for the progress of the product family evolution process;

— providing past best practices of the product family evolution process;

— monitoring data from the progress of the product family evolution process;

— assessing the progress of the product family evolution process;

— controlling and aligning the progress of the product family evolution process if deviations exist;

— providing information that should be informed to the relevant stakeholders.

A tool should support monitoring the progress of the product family evolution process by allowing the user to do the following:

— monitor and assess activities throughout the product family evolution process;

— communicate the progress of the product family evolution process with related stakeholders;

— retrieve and access all planned product family evolution artefacts for review and reference.

7.6.5 Evaluate the result of the product family evolution

The goal of this task is to decide whether the product family evolution adheres to its processes and achieves its evolution goals. According to the evaluation results, follow-up actions are triggered; and lessons are recorded for the further evolution plans.

The method should support evaluating the result of the product family evolution with the following capabilities:

— assessing whether the results are sufficient to achieve its evolution goals;

— providing rationale and objective evidences of the effectiveness and efficiency of the results;

— triggering follow up action(s), if necessary, for the product family evolution;

— documenting and maintaining the results of the product family evolution;

— learning from actual (versus expected) results of the execution.

A tool should support evaluating the result of the product family evolution by allowing the user to do the following:

— retrieve and access the results of the product family evolution for review and reference;

— maintain the result of the product family evolution.

8 Product management support

8.1 General

Product management support deals with the following subprocesses:

— *Role management in product management.*

— *Decision support in product management.*

— *Risk management in product management.*

8.2 Role management in product management

8.2.1 Principal constituents

8.2.1.1 Purpose

The purpose of this subprocess is to identify, coordinate, assign and improve roles and responsibilities for performing product management.

8.2.1.2 Inputs

The following inputs should be available to perform the role management in the product management process:

— Product line goals (objectives).

— Market situations, technology trends and emerging best practices.

— Organization structure of a product line.

— Product management processes including key procedures.

— Plans and schedules for product management.

8.2.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the role management in the product management process:

— *Roles and responsibilities for product management* are identified, coordinated and assigned.

— *Guides for the execution of roles and responsibilities in product management* are defined.

— *Roles and responsibilities of product management* are monitored, measured, controlled and improved.

8.2.1.4 Tasks

The organization shall implement the following tasks with respect to the role management in the product management process:

— *Identify and structure roles and responsibilities for product management*: Define essential roles and responsibilities for product management enablement, operation and support.

— *Coordinate identified roles and responsibilities with the organization structure*: Coordinate the identified roles and responsibilities with the product line organization structure.

— *Guide the execution of roles and responsibilities in product management*: Specify guidance to be followed when each role and responsibility is delivered to the organization units for product management.

— *Assign the roles and responsibilities of product management*: Assign the defined roles and responsibilities to proper organization units.

— *Monitor, measure and control the roles and responsibilities of product management*: Examine deviations between assigned and required roles and responsibilities of product management.

— *Improve the structure of roles and responsibilities in product management*: Take actions to resolve deviations between deployed and required roles and responsibilities of product management.

8.2.2 Identify and structure roles and responsibilities for product management

The goal of this task is to define necessary roles and responsibilities for product management enablement, operation and support. Role and responsibilities required for delivering product management are clearly identified and defined.

The method should support identifying and structuring roles and responsibilities for product management with the following capabilities:

— identifying and structuring roles and responsibilities for product management enablement;

— identifying and structuring roles and responsibilities for product management operation;

— identifying and structuring roles and responsibilities for product management support;

— aligning the roles and responsibilities for product management in accordance with the product line organizational structure and the defined product management procedures;

— assigning the roles and responsibilities to the appropriate units of the product line organizational structure.

A tool should support identifying and structuring roles and responsibilities for product management by allowing the user to do the following:

— obtain historical and current roles and responsibilities of product management;

— access existing roles and responsibilities of the product line organization;

— share roles and responsibilities for product management through communication channels and implemented mechanisms;

— identify existing and/or potential conflicts among roles and responsibilities of product management.

8.2.3 Coordinate identified roles and responsibilities with the organization structure

The goal of this task is to coordinate, integrate and synchronize the identified roles and responsibilities with the product line organization structure.

The method should support coordinating identified roles and responsibilities with organization structure with the following capabilities:

— providing mechanisms and procedures for effective coordination with other roles in a product family;

— identifying conflicts between other roles in a product family and those of product management;

— identifying overlapped roles with other roles or missing roles in a product family;

— determining whether product management roles are to be improved or refined for enhancing the whole product family.

A tool should support specifying how to coordinate with other roles in a product family by allowing the user to do the following:

— access best practices on mechanisms and procedures for effective coordination with other roles in a product family;

— analyse conflict, overlapping or missing roles.

8.2.4 Guide the execution of roles and responsibilities in product management

The goal of this task is to specify guidance to be followed when each role and responsibility is delivered for product management, including evolution of a product family. Responsibility on functions, decisions, and/or activities should be clear and agreed upon. Responsibility ensures that accountability is placed with the person, where the accountable person is the individual who is ultimately answerable for the activity or decision. Role portrays what others in the organization think the person is responsible for, how the person should carry out those responsibilities, and what a person actually does in carrying out his/her job. Roles can be individuals, groups or entire departments.

The method should support guiding the execution of roles and responsibilities in product management with the following capabilities:

— guiding roles and responsibilities in product management in terms of functions, decisions and/or activities which are clear and agreed upon;

— getting feedback and buy-in of roles and responsibilities in product management;

— documenting and communicating of roles and responsibilities on product management;

— avoiding confusion of roles and responsibilities in product management;

— updating roles and responsibilities as necessary on an on-going basis.

A tool should support guiding the execution of roles and responsibilities in product management by allowing the user to do the following:

— document the guide;

— get feedback on the effectiveness of the guide;

— document and communicate roles and responsibilities;

— avoid confusion of roles and responsibilities;

— update roles and responsibilities on an on-going basis.

8.2.5 Assign the roles and responsibilities of product management

The goal of this task is to assign the defined roles and responsibilities to proper organization units with corresponding guidance. Domain experts, including market manager, customer interfaces and architects, for example, are assigned to proper roles and responsibilities of product management.

The method should support assigning the roles and responsibilities of product management with the following capabilities:

— identifying certain positions for roles and responsibilities in the organization structure related to product management;

— assigning roles and responsibilities on the identified positions of product management;

— establishing relation channels between intra and inter organization units of a product line.

A tool should support assigning the roles and responsibilities of product management by allowing the user to do the following:

— disseminate roles and responsibilities to make sure everyone understands their parts;

— establish communication mechanisms for relation channels among intra and inter organization units of a product line.

8.2.6 Monitor, measure and control the roles and responsibilities of product management

The goal of this task is to monitor and measure whether the delivered product management activities by the defined roles and responsibilities are efficient and effective. Proper controls are made in accordance with the monitored and measured results.

The method should support monitoring, measuring and controlling the roles and responsibilities of product management with the following capabilities:

— evaluating whether required and desired roles and responsibilities are achieved;

— identifying inconsistencies, overlaps or duplications between the implied responsibilities of an organization unit and the assigned responsibilities;

— identifying parts of the organization structure that reduce the effectiveness of product management works;

— analysing and controlling the root causes of the confusion of roles and responsibilities.

A tool should support monitoring, measuring and controlling the roles and responsibilities of product management by allowing the user to do the following:

— access the roles and responsibilities matrix or organizational chart for reviewing inconsistencies, overlaps or duplications;

— assess each role and responsibility;

— analyse and control the root causes of the confusion of roles and responsibilities.

8.2.7 Improve the structure of roles and responsibilities in product management

The goal of this task is to examine gaps between deployed and required roles and responsibilities of product management, so as to redefine them.

The method should support improving the structure of roles and responsibilities in product management with the following capabilities:

— analysing deviations from required performance/capability of product management necessary to achieve the established product management goals;

— presenting resolution alternatives for removing inconsistencies and obstacles of the effectiveness of product management works due to the confusion of roles and responsibilities;

— establishing action plans and success measures on improvement activities for roles and responsibilities in product management;

— controlling and tracing of improvement activities to closure;

— refining the structure of roles and responsibilities in product management;

— aligning the structure of roles and responsibilities in product management according to the evolutions and changes of a product line.

A tool should support improving the structure of roles and responsibilities in product management by allowing the user to do the following:

— accumulate data related to the improvement of roles and responsibilities in product management;

— analyse deviation from required performance/capability of product management necessary to achieve the established product management goals;

— check the status for the improvement activities;

— disseminate the refined roles and responsibilities to relevant units or functions;

— change communication mechanisms in accordance with the improved structure of roles and responsibilities.

8.3 Decision support in product management

8.3.1 Principal constituents

8.3.1.1 Purpose

The purpose of this subprocess is to provide decision procedure concerning product line product management, guidance for decision execution and assimilating lessons from decision results.

8.3.1.2 Inputs

The following inputs should be available to perform the decision support in the product management process:

— Decision needs for product management.

— Decisions previously made for product management.

— Existing decision procedure for product management.

8.3.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the decision support in the product management process:

— *Decision support policy for product management* is established.

— *Tailored decision procedure for product management* is produced.

— *Guide for decision execution* is provided.

— *Rationale for decisions concerning product management* is documented.

8.3.1.4 Tasks

The organization shall implement the following tasks with respect to the decision support in the product management process:

— *Establish decision support policy for product management*: Define policy that governs decisions made in product management.

— *Tailor decision procedure for product management*: Modify and refine decision procedures in detail for product management.

— *Guide the decision execution for product management*: Provide guidance that should be followed when decisions related to product management are made.

— *Document the rationale for decisions concerning product management*: Specify rationales for decisions made during product management activities.

— *Learn from decision results of product management*: Record lessons from decisions during product management.

8.3.2 Establish decision support policy for product management

The goal of this task is to define the policy, including guides and procedures that govern decision making in product management. Decisions related to family members and domain platforms are the most important in product management. This task utilizes guidance for overall decision procedure provided in ISO/IEC 26555.

NOTE Example for the generic decision procedure is in ISO/IEC 26555:

— Formulate decision goals;

— Define goal achievement measures;

— Generate alternatives;

— Converge on alternatives;

— Evaluate alternatives;

— Select the best alternatives;

— Document the rationale;

— Activate the decision;

— Measure the performance of the decision results;

— Review the gap between the expected and actual goal achievement;

— Analyse root cause of the gap;

— Lessons learn by the learning mechanism.

The method should support establishing the decision support policy for product management with the following capabilities:

— defining policy for the generation, evaluation and selection of decision alternatives regarding product management, which are critical for the effectiveness and efficiency of product family endeavours and for the consequences on business success;

— establishing the decision dissemination policy for relevant product management stakeholders.

A tool should support establishing the decision support policy for product management by allowing the user to do the following:

— share the decision management policy with relevant product management stakeholders;

— communicate the established decision support policy for product management by implementing channels and mechanisms according to decision making structure.

8.3.3 Tailor decision procedure for product management

The goal of this task is to modify and refine decision procedures in detail for product management based on procedures defined in the policy.

The method should support tailoring decision procedure for product management with the following capabilities:

— tailoring decision making procedures for product management, which are critical for the effectiveness and efficiency of product family endeavours and for the consequences on business success;

— providing a documentation template for describing the tailored decision procedure for product management;

— integrating the tailored decision procedures for product management;

— defining the dissemination method of the tailored decision procedures specific to product management.

A tool should support tailoring the decision procedure for product management by allowing the user to do the following:

— document the tailored decision procedure according to the documentation template;

— integrate the tailored decision procedures for product management;

— share the tailored decision procedures with relevant stakeholders of product management.

8.3.4 Guide the decision execution for product management

The goal of this task is to provide guidance followed when decisions are made during product management activities.

The method should support guiding the decision execution for product management with the following capabilities:

— guiding decision execution practices for ensuring the successful decision making in product management;

— defining mechanisms to support multi-criteria decision making;

— coordinating decision execution mechanisms to be harmonized for the effectiveness and efficiency of product family endeavours and for the consequences on business success;

— measuring the effectiveness of decision making on product management.

A tool should support guiding the decision execution for product management by allowing the user to do the following:

— share decision execution guides for product management;

— establish multi-criteria decision support mechanisms for product management;

— measure the effectiveness of decision making on product management.

8.3.5 Document the rationale for decisions concerning product management

The goal of this task is to describe rationales for decisions occurred during product management activities, so that decisions made can be referenced in order that future decisions can be more effective and efficient.

The method should support documenting the rationale for decisions concerning product management with the following capabilities:

— identifying decision rationale concerning product management in an objective way;

— providing a documentation template for the rationale for decisions concerning product management;

— sharing the decision rationale with relevant stakeholders.

A tool should support documenting the rationale for decisions concerning product management by allowing the user to do the following:

— document the rationale for decisions concerning product management according to the documentation template;

— communicate the decision rationale with relevant stakeholders.

8.3.6 Learn from decision results of product management

The goal of this task is to record lessons from decisions made and preserve the results for the later decisions that will be made during product management activities.

The method should support learning from decision results of product management with the following capabilities:

— reviewing consequences of decisions in regard to product management;

— reviewing the decision dissemination process of product management;

— learning what product management activities should be aligned with decisions and choices, and vice versa;

— learning decision making practices from previous decisions;

— preserving the lessons learned for next decisions.

A tool should support learning from decision results of product management by allowing the user to do the following:

— access the consequences of decisions for product management;

— access lessons learned for next decisions for product management.

8.4 Risk management in product management

8.4.1 Principal constituents

8.4.1.1 Purpose

The purpose of this subprocess is to deal with risks related to variability and platform for business, technology and competitiveness of a product family and to develop a mitigation plan for these risks.

8.4.1.2 Inputs

The following inputs should be available to perform the risk management in product management process:

— Probable risk sources (e.g. customers, competitors, market situations, technology trends, etc.).

— Organizational-level product line plans (i.e. sourcing strategy, transition plan, operations plan, product line evolution plan, value management plan, operations plan, etc.).

— Outcomes of technical probe.

— Technical risk management subprocess in ISO/IEC 26555.

— Organizational risk management subprocess in ISO/IEC 26556.

8.4.1.3 Outcomes

The following outcomes shall be available as a result of the successful implementation of the risk management in product management process:

— *Risks stem from sources (e.g. customers, competitors, market situations, technology trends, etc.) in product management* are identified and documented.

— *Risks related to the variability of a product family* are identified and documented.

— *Risks related to the platform of a product family* are identified and documented.

— *Analysis results of identified risks* are documented.

— *Mitigation plans and risk monitoring plans* are developed and documented.

— *Risk mitigation results* are assessed and reported.

— *Lessons learned* are evaluated and documented.

8.4.1.4 Tasks

The organization shall implement the following tasks with respect to the risk management in product management process:

— *Identify risks related to the platform and variability (due to customers, competitors, market situations, technology trends, etc.) in a product family*: Identify risks related to the defined product family.

— *Assess the identified risks related to the platform and variability*: Evaluate the identified risks and their severity.

— *Develop mitigation plans for the risks*: Prepare risk mitigation or contingency plans for the risks related to the defined product family.

— *Monitor the execution of the mitigation plan*: Monitor and measure the risk status during and after executing mitigation plans for the risks in a product family.

— *Learn from actual (vs. expected) results of the execution*: Summarize lessons learned from actual versus expected results of risk management execution for the risks in a product family.

8.4.2 Identify risks related to the platform and variability in a product family

The goal of this task is to identify severe risks, related to the platform and variability in a product family, which stem from business, technology and competitiveness sources (e.g. customers, competitors, market situations, technology trends, etc.).

The method should support identifying risks for the platform and variability of a product family with the following capabilities:

— analysing sources of risks (e.g. customers, competitors, market situations, technology trends, etc.);

— identifying potential risks associated with the product family platform;

— identifying potential risks associated with the variability;

— identifying potential risks associated with product management in general.

A tool should support identifying risks for the platform and variability of a product family by allowing the user to do the following:

— access product family-related artefacts produced during product management;

— share risk sources;

— accumulate historical data for capturing risks;

— identify potential risks associated with the variability and platform.

8.4.3 Assess the identified risks related to the platform and variability

The goal of this task is to evaluate the identified platform and variability risks by estimating risk probability and its consequences.

The method should support assessing the identified platform and variability risks with the following capabilities:

— evaluating the risks as to likelihood and consequences;

— assessing the options for accommodating the risks;

— analysing relations with other risks;

— prioritizing risks in accordance with their severity;

— establishing a risk baseline for platform and variability risks.

A tool should support assessing the identified platform and variability risks by allowing the user to do the following:

— share risks that threaten the platform and variability of a product family with the geographically distributed stakeholders;

— document the risk assessment results including their priorities;

— maintain a risk baseline for platform and variability risks.

8.4.4 Develop mitigation plans for the risks

The goal of this task is to prepare risk mitigation or contingency plans for the risks that are related to the platform and variability in a product family.

The method should support developing a mitigation plan for the risks related to the platform and variability in a product family with the following capabilities:

— determining risk mitigation efforts for the risks related to the platform and variability of a product family;

— developing risk mitigation plans for the risks related to the platform and variability of a product family;

— identifying triggering criteria of mitigation plans;

— aligning collaboration among different organization units for the risks related to the platform and variability of a product family.

A tool should support developing a mitigation plan for the risks related to the platform and variability in a product family by allowing the user to do the following:

— estimate risk mitigation efforts;

— maintain risk mitigation plans for platform and variability risks.

8.4.5 Monitor the execution of the mitigation plan

The goal of this task is to monitor and measure the risk status during and after executing mitigation plans for the risks that are related to the platform and variability in a product family.

The method should support monitoring the execution of the mitigation plan for the risks that are related to the platform and variability in a product family with the following capabilities:

— initiating the mitigation plans for the risks that are related to the platform and variability in a product family;

— monitoring the triggering conditions of mitigation plans;

— tracking the readiness of risk mitigation action items;

— tracking the risk status to check for the effectiveness of mitigation actions;

— collecting measurement values on the risk handling activities.

A tool should support monitoring the execution of the mitigation plan for the risks that are related to the platform and variability in a product family by allowing the user to do the following:

— display the risk mitigation status using a status dashboard;

— trace risk mitigation action items;

— collect measurement values;

— visualize risk status (e.g. threshold graph);

— collaborate with participants or stakeholders for parallel management of risks.

8.4.6 Learn from actual results of the execution

The goal of this task is to summarize lessons learned from actual versus expected results of the risk management execution for the risks that are related to the platform and variability in a product family.

The method should support learning from actual results of the execution for the risks that are related to the platform and variability in a product family with the following capabilities:

— analysing actions taken to reduce or control risks that are related to the platform and variability in a product family;

— reviewing consequences of the execution of the mitigation plan;

— evaluating success or failure in actions taken to reduce or control risks;

— preserving the lessons learned from the execution.

A tool should support learning from the actual result of the execution for the risks that are related to the platform and variability in a product family by allowing the user to do the following:

— access consequences of the actual results of the execution of the mitigation plans for the risks that are related to the platform and variability in a product family;

— access lessons learned for the next execution of the mitigation plans.

Annex A
(informative)

Relationships between product management and other key roles in SSPL

Figure A.1 describes how this document is related to other key roles of SSPL.

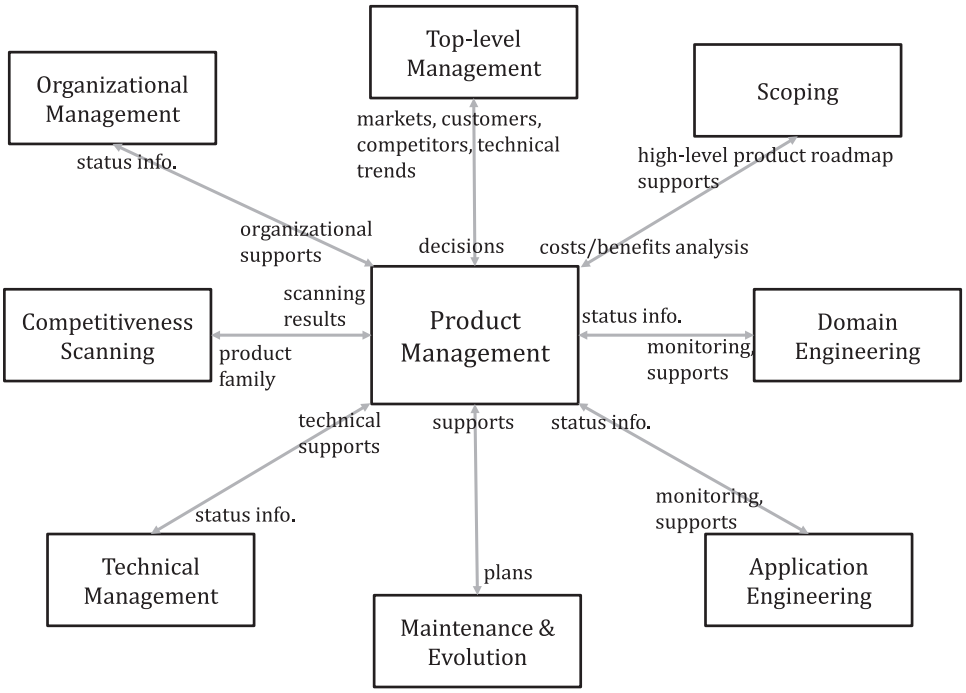

Figure A.1 — Relationships between product management and other key roles in SSPL

Annex B
(informative)

Exemplary analysis methods for trade-offs

A trade-off means giving up one thing to gain another. In product management, there are multiple decision makers, stakeholders and other interested parties making inputs to the decision-making process. Product management incorporates three stages (i.e., planning, evaluation and selection) that are associated with trade-off analysis:

In the planning stage, the product management team decides the scope, roadmap, development schedule and such for specific alternative scenarios. These plan-building decisions often provide the product management team their first encounter with value trade-offs. In the evaluation stage, the product management team should select the evaluation criteria they will use to evaluate and compare their alternative scenarios. Then the team decides whether or not each scenario qualifies for further consideration based on its own merits. The selection stage is the final round of trade-off analysis among scenarios, and, as such, it requires a keener appreciation for the values of decision makers. Decision makers may follow the recommendation of product management team, or they may impose their own decision.

The decision will be made based on the consideration of specific criteria or attributes. Different kinds of decisions require different criteria. Roy Bernard defines a set of criteria as coherent if the following three properties (i.e., exhaustiveness, consistency and non-redundancy) are satisfied: The decision criteria should be carefully formulated to express all the objectives and attributes considered in the actual decision, thus, exhaustiveness is satisfied when no important criterion has been forgotten. Consistency means if the decision maker is indifferent between Scenario A and Scenario B, and then Scenario A is improved with respect to one criterion, and/or Scenario B degrades with respect to one criterion then it should be true that Scenario A is then preferred to Scenario B. Otherwise the criteria are inconsistent with respect to the decision maker's preferences. Redundancy is of particular importance in multicriteria trade-off analysis. The risk with redundancy is that too much importance can be afforded to a criterion that appears in two or more similar forms.

Trade-off concept allows a poor performance on one criterion to be compensated by a superior performance on another in different scenarios. This analysis is designed to establish equivalent scale alternatives that only differ in the scale level of one criterion. Indifferent curves or efficient frontiers are often used to create equivalent scale alternatives. However, there is no mechanism that can automatically generate equivalent scale alternatives.

The following is exemplary analysis methods for trade-offs:

- Weighting Methods;
  - Non-Normalized Weighted Products;
  - Normalized Weighted Products;
- Effects Matrix;
- Ranking Index;
  - Direct Weights;
  - Ordinal Ranking;
  - Borda's Method;
  - Fishburn's Method;

  - Unequal Weights;
  - Multiple Attribute Utility Theory;
  - Outranking Methods;
- Thomas L. Saaty's AHP (Analytic Hierarchy Process).

No attempt is made to be comprehensive in describing the strengths and weaknesses of the above methods since each of which has an extensive literature explaining it. There exist, however, also a large number of variations on each of these methods.

There are trade-offs in the choice of methods to be used for trade-off analysis. Ease of use, transparency, replicability and effectiveness are valued over the rigor that often comes only with complexity and sophistication. If an analytical trade-off tool like one of the multicriteria decision-making methods of this annex is going to be effectively used to discriminate among scenarios, the tool needs to get buy-in from the stakeholders of product management.

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