

6.2 Stakeholder requirements definition process

6.2.1 Purpose

The purpose of the Stakeholder Requirements Definition Process is to define the requirements for a system that can provide the services needed by users and other stakeholders in a defined environment.

It identifies stakeholders, or stakeholder classes, involved with the system throughout its life cycle, and their needs, expectations, and desires. It analyzes and transforms these into a common set of stakeholder requirements that express the intended interaction the system will have with its operational environment and that are the reference against which each resulting operational service is validated.

6.2.2 Outcomes

As a result of the successful implementation of the Stakeholder Requirements Definition Process:

- a) The required system characteristics and context of use of the product functions and services, and operational concepts are specified.
- b) The constraints on a system solution are defined.
- c) Traceability of stakeholder requirements to stakeholders and their needs is achieved.
- d) The stakeholder requirements are defined.
- e) Stakeholder requirements for validation are identified.

6.2.3 Activities and tasks

The project shall implement the following activities and tasks in accordance with applicable organization policies and procedures with respect to the Stakeholder Requirements Definition Process.

6.2.3.1 Elicit stakeholder requirements.

This activity consists of the following tasks:

- 1) Identify the individual stakeholders or stakeholder classes who have a legitimate interest in the system throughout its life cycle.

NOTE This includes, but is not limited to, users, operators, supporters, developers, producers, trainers, maintainers, disposers, acquirer and supplier organizations, parties responsible for external interfacing entities or enabling systems, regulatory bodies and members of society. Where direct communication is not practicable (e.g., for consumer products and services), representatives or designated proxy stakeholders are selected.

[ISO/IEC 15288:2008 (IEEE Std 15288-2008), 6.4.1.3 a) 1)]

It is best to identify all stages of the system life cycle, and then identify the individual stakeholders or stakeholder classes who have a legitimate interest in the system throughout its life cycle. Requirements elicited from a stakeholder will be dependent on the role, responsibility, and position of the stakeholder in the organization. Identify all of the stakeholder classes that have a role or interest in the desired product or service. Then identify those stakeholders who have strong influence on goals, strategies, operations, and the target system. The list of stakeholder classes is often modified with time as more is learned about the desired product or service. Representatives from each stakeholder class should be identified and include multi-level perspectives. Information gathered from only one stakeholder class, or only one level, is likely to be biased from a single perspective. A representative cross-section of stakeholders is necessary to provide the true picture of the 'problem to be solved'.

- 2) Elicit stakeholder requirements from the identified stakeholders.

NOTE Stakeholder requirements describe the needs, wants, desires, expectations and perceived constraints of identified stakeholders. They are expressed in terms of a model that may be textual or formal, that concentrates on system purpose and behaviour, and that is described in the context of the operational environment and conditions. A product quality model and quality requirements, such as found in ISO/IEC 9126-1 and ISO/IEC 25030, may be useful for aiding this activity. Stakeholder requirements include the needs and requirements imposed by society, the constraints imposed by an acquiring organization and the capabilities and operational characteristics of users and operator staff. It is useful to cite sources, including solicitation documents or agreements, and, where possible, their justification and rationale, and the assumptions of stakeholders and the value they place on the satisfaction of their requirements. For key stakeholder needs, the measures of effectiveness are defined so that operational performance can be measured and assessed. If significant risks are likely to arise from issues (i.e. needs, wants, constraints, limits, concerns, barriers, factors or considerations) relating to people (users and other stakeholders) and their involvement in or interaction with a system at any time in the life cycle of that system, recommendations for identifying and treating human-system issues can be found in ISO PAS 18152, *A specification for the process assessment of human-system issues*.

[ISO/IEC 15288:2008 (IEEE Std 15288-2008), 6.4.1.3 a) 2)]

NOTE 1 Subclause 5.2.3 describes the use of the Concept of Operations and the System Operational Concept as tools to elicit, document and capture the information needed to build requirements. Annex A contains the essential elements for the System Operational Concept and Annex B contains this information for the Concept of Operations.

NOTE 2 There are very few systems for which there are no significant risks related to use, users, operators, maintainers, or some source of human-system issues.

In most systems, there will be many sources of requirements and it is essential that all potential sources are identified and evaluated for their impact on the system. Some of the common sources of requirements and issues that need to be dealt with are:

- Goals – The term 'Goal' (sometimes called 'business concern' or 'critical success factor') refers to the overall, high-level objectives of the system. Goals provide the motivation for a system but are often vaguely formulated. It is important to assess the value (relative to priority) and cost of goals.
- Mission profile – How will the system perform its mission? How will the system contribute to business or organizational operations?
- Operational scenarios – Are there any special scenarios that need to be accounted for? Scenarios can be used to define operational concepts and to bound the range of anticipated uses of system products, the intended operational environment and interfacing systems, platforms or products. Scenarios help identify requirements that might otherwise be overlooked.
- Operational environment and context of use – Requirements will be derived from the environment in which the system or software product will operate. Will it operate in hot or cold conditions, externally, or other equally restrictive conditions? What are the characteristics, timing, and quantity (workload) of interactions with the system environment? Are there any timing constraints in a real-time system or interoperability constraints in a business environment such as constraints in operational hours? Other aspects of the environment (threats and interoperating systems) can also lead to requirements upon the system. These can greatly affect system feasibility and cost, and restrict design choices.
- Operational deployment – When will the system be used? Will it be deployed during the initial, middle, or wrap up phases of a need?
- Performance – What are the critical system parameters to accomplish the mission?
- Effectiveness – How effective/efficient should the system be in performing its mission? What are the applicable measures of effectiveness? Does the system have to be available to perform its missions a minimum amount of time, such as 90-percent of the time?
- Operational life cycle – How long will the system's life time be? 20 years? 30 years? How many hours per year should the system operate?
- Organizational environment – Many systems are required to support an organization's process and this may be conditioned by the structure, culture, and internal politics of the organization. In general, new systems should not force unplanned change to the business process.
- User and operator characteristics – Who will be using or operating the system? How will they vary in role, skill level and expected workload? What are the expectations or constraints on their capability and availability? Should allowance be made for accessibility?

NOTE 3 See ISO/IEC TR 29138-1:2009, *Information technology— Accessibility considerations for people with disabilities — Part 1: User needs summary*, for additional information on accessibility.

As part of this task, it is important to identify and assess opportunities to reuse previously existing requirements. This includes identification of existing systems that provide similar functions or capabilities, specified functions or capabilities applicable to the new system-of-interest, and information on the extent of reusability.

NOTE 4 See ISO/IEC 26551, *Information technology— Tools and methods of requirements engineering and management for product lines* for additional guidance on requirements reuse.

Requirements elicitation is an iterative activity. Consider several different techniques for identifying requirements during the elicitation task to better accommodate the diverse set of requirements sources, including:

- Structured workshops with brainstorming
- Interviews, questionnaires
- Observation of environment or work patterns (e.g., time and motion studies)
- Technical documentation review
- Market analysis or competitive system assessment
- Simulations, prototyping, modelling
- Benchmarking processes and systems
- Organizational analysis techniques (e.g., Strength – Weakness – Opportunity - Threat analysis, product portfolio)

System stakeholders will be authoritative sources for requirements of the system that represent their interests or area(s) of expertise. However, they usually are not familiar with how to transform their expertise into well formed requirements statements. In addition to these human sources of requirements, important system requirements often are imposed by other systems in the environment that require some services of the system, or act to constrain the system, or even from fundamental characteristics of the application domain. There may also be safety or other regulatory constraints that drive system requirements.

A description of the user community (typically found in the organization concept of operations) may provide common understanding across the effort and validate the appropriateness of scenarios. A user description may cover the demographic group(s) to which a product will be marketed or the specific personnel categories that will be assigned to employ the system or otherwise benefit from its operation.

Involving the stakeholders in the verification of the stakeholder requirements (e.g., well-formed requirements) during stakeholder requirements elicitation can also aid early validation by those stakeholders that the statements accurately capture their needs. Apply the characteristics and guidelines for building well-formed requirements statements provided in subclause 5.2.

6.2.3.2 Define stakeholder requirements.

This activity consists of the following tasks:

1) Define the constraints on a system solution that are unavoidable consequences of existing agreements, management decisions and technical decisions.

NOTE These may result from 1) instances or areas of stakeholder-defined solution 2) implementation decisions made at higher levels of system hierarchical structure 3) required use of defined enabling systems, resources and staff.

[[ISO/IEC 15288:2008 (IEEE Std 15288-2008), 6.4.1.3 b) 1]]

Constraints are one type of requirement. They may be imposed by:

- External or organization stakeholders (e.g., engineering plans, technical performance measures, technical maturity, regulations, life cycle costs, or user and operator staffing constraints).
- External, interacting, or enabling systems.
- Activities from other life cycle phases and technical activities such as Transition, Operation, and Maintenance.
- Measures of effectiveness and suitability that reflect overall acquirer/user satisfaction (e.g., performance, safety, reliability, availability, maintainability, and workload requirements).

Examples of constraints include: 1) the budget limit required by top management is a constraint for succeeding requirement processes, and 2) the maintenance strategy developed for the system may impose conditions or constraints on requirements (repair times and/or spares levels may drive reliability values), or may define capability requirements directly (e.g., built-in-test functionality to support maintenance fault isolation).

2) Define a representative set of activity sequences to identify all required services that correspond to anticipated operational and support scenarios and environments.

NOTE Scenarios are used to analyze the operation of the system in its intended environment in order to identify requirements that may not have been formally specified by any of the stakeholders, e.g., legal, regulatory and social obligations. The context of use of the system is identified and analyzed. Include in the context analysis the activities that users perform to achieve system objectives, the relevant characteristics of the end-users of the system (e.g., expected training, degree of fatigue), the physical environment (e.g., available light, temperature) and any equipment to be used (e.g., protective or communication equipment). The social and organizational influences on users that could affect system use or constrain its design are analyzed when applicable.

[ISO/IEC 15288:2008 (IEEE Std 15288-2008), 6.4.1.3 b) 2]

Scenarios can be used to define the concept documents and bound the range of anticipated uses of system products, the intended operational environment and interfacing systems, platforms or products. Scenarios help identify requirements that might otherwise be overlooked. Scenarios may help to establish critical and desired system performance thresholds and objectives for system performance parameters that are critical for system success. They may also establish those that are desired but may be subject to compromise in order to meet the critical parameters. Use case approaches can also be used to define concept documents. Under this approach, a set of actors (systems and classes of people that interact with the system) is identified, along with their goals, purposes, and needs for the system. The use cases are analyzed to identify stakeholder requirements.

Different levels of abstraction or presentation mechanisms will often be necessary to address the full range of stakeholders, including the acquirer, user, and supplier.

3) Identify the interaction between users and the system.

NOTE Usability requirements are determined, establishing, as a minimum, the most effective, efficient, and reliable human performance and human-system interaction. The interaction should take into account human capabilities and skills limitations. Where possible, applicable standards, e.g., ISO 9241, and accepted professional practices are used in order to define:

- i) Physical, mental, and learned capabilities;
- ii) Work place, environment and facilities, including other equipment in the context of use;
- iii) Normal, unusual, and emergency conditions;
- iv) Operator and user recruitment, training and culture;

If usability is important, usability requirements should be planned, specified, and implemented through the life cycle processes, and the following standards or technical reports may be applicable:

- ISO 9241-11:1998, *Ergonomic requirements for office work with visual display terminals (VDTs) — Part 11: Guidance on usability*;
- ISO 13407:1999, *Ergonomics — Ergonomics of human-system interaction — Human-centred design process for interactive systems*.

[ISO/IEC 15288:2008 (IEEE Std 15288-2008), 6.4.1.3 b) 3)]

Consideration of human systems integration (HSI) is an important concept within systems engineering. HSI focuses on the human over the system life cycle. It promotes a total system approach which includes humans, technology (hardware and software), the operational context, and the necessary interfaces among the system elements to make them work in harmony. HSI brings human-centred disciplines (such as manpower, personnel, training, human factors, environment, health, safety, habitability, and survivability) into the systems engineering process to improve the overall system design and performance. Incorporation of HSI considerations into requirements is contingent upon a clear understanding of the missions, functions, operational scenarios and tasks, user population, and quality characteristic considerations. Requirements in the areas of user tasks and performance, manpower, and training can only be defined through decomposition of the goals or missions of the system down to the level of task analyses to define characteristics of the user interface or front end analyses to determine training impacts.

NOTE ISO 13407:1999 has been replaced by ISO 9241-210, *Ergonomics of human-system interaction - part 210: Human-centred design for interactive systems*.

4) Specify health, safety, security, environment and other stakeholder requirements and functions that relate to critical qualities.

NOTE Identify safety risk and, if warranted, specify requirements and functions to provide safety. This includes risks associated with methods of operations and support, health and safety, threats to property and environmental influences. Use applicable standards, e.g., IEC 61508, and accepted professional practices. Identify security risk and, if warranted, specify all applicable areas of system security, including physical, procedural, communications, computers, programs, data and emissions. Identify functions that could impact the security of the system, including access and damage to protected personnel, properties and information, compromise of sensitive information, and denial of approved access to property and information. Specify the required security functions, including mitigation and containment, referencing applicable standards and accepted professional practices where mandatory or relevant.

[ISO/IEC 15288:2008 (IEEE Std 15288-2008), 6.4.1.3 b) 4)]

6.2.3.3 Analyze and maintain stakeholder requirements.

This activity consists of the following tasks:

- 1) Analyze the complete set of elicited requirements.

NOTE Analysis includes identifying and prioritizing the conflicting, missing, incomplete, ambiguous, inconsistent, incongruous or unverifiable requirements.

[ISO/IEC 15288:2008 (IEEE Std 15288-2008), 6.4.1.3 c) 1)]

Requirements should be analyzed for the characteristics defined in subclauses 5.2.5 and 5.2.6. Requirements should be prioritized and may be classified as described in subclause 5.2.8. The use of checklists or standard templates helps in the review process.

If stakeholder requirements from existing or legacy systems have been identified as candidates for reuse, then they should be analyzed for use, based on factors such as applicability, feasibility, availability, quality, cost effectiveness, value, and currency. While reusing requirements, a careful consistency check of reused requirements with the system-of-interest's specific requirements should be performed in order to assure consistency.

- 2) Resolve requirements problems.

NOTE This includes requirements that cannot be realized or are impractical to achieve.

[ISO/IEC 15288:2008 (IEEE Std 15288-2008), 6.4.1.3 c) 2)]

It is important to continue to perform requirements negotiation during the analysis and allocation of requirements, because conflicts will occur. Negotiation might be needed among stakeholders requiring mutually incompatible features, or due to conflicts between desired performance requirements, constraints, available budget, and delivery schedule. In most cases, it is necessary to consult with the stakeholder(s) to reach a consensus on an appropriate trade-off. It is often important for contractual reasons that such decisions are traceable to the stakeholder. Various analysis methods and conflict resolution techniques may be applicable to facilitate the resolution and are dependent on the specific situation.

Some organizations consider requirements negotiation to be part of requirements validation. The specific process subcategory is not important as long as the conflict resolution occurs as early as possible in the requirements analysis task.

- 3) Feed back the analyzed requirements to applicable stakeholders to ensure that the needs and expectations have been adequately captured and expressed.

NOTE Explain and obtain agreement to the proposals to resolve conflicting, impractical and unrealisable stakeholder requirements.

[ISO/IEC 15288:2008 (IEEE Std 15288-2008), 6.4.1.3 c) 3)]

- 4) Establish with stakeholders that their requirements are expressed correctly.

NOTE This includes confirming that stakeholder requirements are comprehensible to originators and that the resolution of conflict in the requirements has not corrupted or compromised stakeholder intentions.

[ISO/IEC 15288:2008 (IEEE Std 15288-2008), 6.4.1.3 c) 4)]

It is normal for there to be one or more formally scheduled points in the requirements engineering process where the requirements are validated. The objective is to identify any problems before resources are committed to implementing a system solution for the requirements. Requirements validation is concerned with the process of examining the requirements set to ensure that it defines the right system, i.e. the system that the stakeholder expects. The most common activities in requirements validation are conducting requirements reviews, simulation, and prototyping.

Conducting requirements reviews is perhaps the most common means of both verification and validation of the requirements document(s). A group of reviewers is constituted with a brief to look for errors, mistaken assumptions, lack of clarity, verifiability issues and deviation from standard practice. The composition of the group that conducts the review is important (at least one representative of the acquirer should be included for an acquirer-driven project, for example) and it may help to provide guidance on what to look for in the form of checklists.

Reviews may be conducted at any level of abstraction in the set of requirements. Various types of reviews may be applicable throughout the development and maintenance of the requirements, including technical reviews, inspections, and walk-throughs. Effective early requirements review and validation can be achieved using low fidelity prototypes to obtain feedback from potential users of the system.

NOTE 1 Additional guidance on reviews can be found in IEEE Std 1028-2008, *Standard for Software Reviews and Audits*.

NOTE 2 Discussion on prototyping and simulation is contained in subclause 6.3.3.2.

5) Record the stakeholder requirements in a form suitable for requirements management throughout the life cycle and beyond.

NOTE These records establish the stakeholder requirements baseline, and retain changes of need and their origin throughout the system life cycle. They are the basis for traceability to the system requirements and form a source of knowledge for requirements for subsequent system entities.

[ISO/IEC 15288:2008 (IEEE Std 15288-2008), 6.4.1.3 c) 5)]

Consideration should be given to using a requirements management tool, especially for more complex projects. This tool should have the capability to trace linkages between requirements to show relationships. A requirements management tool is intended to facilitate and support the systematic managing of requirements throughout the project life cycle. This includes, but is not limited to, requirements elicitation, requirements analysis, requirements change management, requirements reuse and requirements quality assessment.

NOTE Additional information and guidelines on requirements management tools can be found in ISO/IEC TR 24766:2009 – *Guide for requirement engineering tool capabilities*.

The requirements repository should first be populated with the source documentation of the stakeholder needs, project constraints (such as from business policies/rules or regulatory requirements), and any other conditions that provide the basis for the total set of system requirements that will govern its design. Both the source and rationale for each requirement needs to be captured.

Requirements documents that may be output as part of the Stakeholder Requirements Definition process include:

- Stakeholder Requirements Specification
- Concept of Operations
- System Operational Concept

Additional information on these requirements-related documents can be found in Clauses 7 through 9 and Annex A and B.

The requirements repository should also include any requirements attributes, including the priority and criticality of the requirements. Additional information on requirements attributes can be found in subclause 5.2.8.

6) Maintain stakeholder requirements traceability to the sources of stakeholder need.

NOTE The stakeholder requirements are reviewed at key decision times in the life cycle to ensure that account is taken of any changes of need.

[[ISO/IEC 15288:2008 (IEEE Std 15288-2008), 6.4.1.3 c) 6]]

Initial requirements traceability should be established and maintained to document how the formal requirements are intended to meet the stakeholder objectives and achieve stakeholder agreement. Stakeholder requirements need to be captured, traced, and maintained throughout the system life cycle and beyond, and placed under configuration control. Use of a requirements management tool can facilitate this process. More discussion on the application of traceability can be found in subclause 6.3.3.2 of this International Standard under task 3.

NOTE 1 Additional guidance on placing information under configuration control can be found in ISO/IEC 15288, subclause 6.3.5, and in subclause 6.5.2.1 of this International Standard.

NOTE 2 Subclause 5.2.5 describes requirements traceability as it pertains to requirements engineering.

8.2 Stakeholder requirements specification document

8.2.1 Introduction

The Stakeholder Requirements Specification (StRS) describes the organization's motivation for why the system is being developed or changed, defines processes and policies/rules under which the system is used and documents the top level requirements from the stakeholder perspective including needs of users/operators/maintainers as derived from the context of use. In a business environment, the StRS describes how the organization is pursuing new business or changing the current business in order to fit a new business environment, and how to utilize the system as a means to contribute to the business. The description includes, at the organization level; the organizational environment, goals and objectives, the business model, and the information environment, and, at the business operation level; the business operation model, business operation modes, business operational quality, organizational formation, and concept of the proposed system.

The information items of the StRS should be specified by the stakeholders. The stakeholders should be responsible for the content of the specification. The StRS serves as the basis of the stakeholders' active participation in the requirement processes. Typical types of stakeholder requirements included in the StRS are organizational requirements, business requirements, and user requirements.

NOTE 1 ISO/IEC/IEEE 15289 provides guidance to include business, organizational, and user (stakeholder) requirements in the system requirements specification. This International Standard includes these requirements in the StRS since the contents should be specified from the stakeholders' perspective. They may be succeeded in the SyRS by addressing technical concerns.

NOTE 2 The StRS is often identified with the business requirement specification (BRS) in many industries. Users of this International Standard may replace StRS with BRS according to the users' environment.

NOTE 3 The stakeholder requirements and business requirements are distinguished in *The Guide to the Business Analysis Body of Knowledge (BABOK)* as follows: Business Requirements are high-level statements of the goal, objectives, or needs of the enterprise. They describe why a project is initiated, what the project will achieve, and which metrics will be used to measure the project's success. Stakeholder Requirements are statements of the needs of a particular stakeholder or class of stakeholders. They describe the needs that a given stakeholder has and how that stakeholder will interact with a solution. Stakeholder Requirements serves as a bridge between Business Requirements and the various classes of solution requirements.

8.2.2 StRS example outline

The specific requirements clause of the StRS should be organized such that a consensus of the stakeholders agrees that the organization method aids understanding of the requirements. There is no one optimal organization for all projects. An example outline of a StRS created in an organizational/business context is shown in Figure 6.

1. Introduction
1.1 Business purpose
1.2 Business scope
1.3 Business overview
1.4 Definitions
1.5 Stakeholders
2. References
3. Business management requirements
3.1 Business environment
3.2 Goal and objective
3.3 Business model
3.4 Information environment
4. Business operational requirements
4.1 Business processes
4.2 Business operational policies and rules
4.3 Business operational constraints
4.4 Business operational modes
4.5 Business operational quality
4.6 Business structure
5. User requirements
6. Concept of proposed system
6.1 Operational concept
6.2 Operational scenario
7 Project Constraints
8. Appendix
8.1 Acronyms and abbreviations

Figure 6 — Example StRS Outline