In addition to the quality criteria suggested in the literature, we define further quality criteria for requirements artefacts and requirements documents which are derived from the three dimensions of requirements engineering in Section 27.3.

16.4 Acceptance Criteria

Acceptance test and acceptance criteria

An acceptance criterion defines a rule for checking a development artefact during a formal acceptance test of the system. In order to pass the acceptance test successfully, the considered artefact (e.g. the implemented system or a requirements artefact) must fulfil all defined acceptance criteria. If an artefact does not pass the acceptance test successfully (i.e. if it does not fulfil all required acceptance criteria) the artefact must be adapted accordingly and the acceptance test must be re-executed. Hence, acceptance criteria define the conditions for the acceptance of an artefact in such a verifiable, measurable way.

The requirements engineers should know the acceptance criteria for the requirements artefacts as early as possible in order to allow them to choose appropriate methods and tools for developing the artefacts in a way that they fulfil the acceptance criteria.

Objective verifiability

Acceptance criteria must facilitate an objective test of whether the criteria are fulfilled or not. This means that an acceptance criterion must not give leeway to misinterpretation or intentional manipulation. It should be possible to verify without doubt whether the checked artefact meets the acceptance criterion or not. Ideally, each acceptance criterion should be related to a set of measures (metrics) against which the fulfilment is checked. Whether a criterion is fulfilled or not should than be checked by comparing the actual values for the defined measures with the pre-defined target values.

Acceptance of requirements vs. acceptance of the system

We differentiate acceptance criteria for requirements artefacts from acceptance criteria for the implemented system. Both kinds of acceptance criteria, those for the acceptance of the requirements as well as those for the acceptance of the implemented system, have to be considered during requirements engineering. In Section 16.4.1, we outline acceptance criteria for individual requirements artefacts as well as for requirements documents. In Section 16.4.2, we outline acceptance criteria for the system, or its components.

16.4.1 Acceptance Criteria for Requirements Artefacts

Refinement of quality criteria

Acceptance criteria for requirements artefacts define which conditions a requirements artefact or the requirements document must fulfil for its successful acceptance. The acceptance criteria refine the documentation rules and guidelines (see Section 16.2) as well as the quality criteria for requirements artefacts (see Sections 16.3) and the requirements document (see Section 17.3). An acceptance criterion for the requirements document can define, for example, that the requirements document must not contain any contradictions, or that only 2% of the requirements are allowed to be underspecified.

Acceptance Criteria for Individual Requirements Artefacts

Inspection instructions for a requirements artefact

Acceptance criteria for individual requirements artefacts are used to verify the acceptance of an individual requirements artefact independently of any other requirements artefacts. Typically, such acceptance criteria refine quality criteria as well as documentation rules and guidelines by defining more detailed criteria, rules, and instructions for assessing whether a requirements artefact is accepted or not (Example 16-4).

Example 16-4: Acceptance criteria for individual requirements

- Each requirements artefact must have a valid identifier. The identifier of a requirement must be unique and structured according to the scheme <Category>-<Number>. Valid labels for categories are G (goal), S (scenario), and R (solution-oriented requirement). Valid numbers must have five digits. Numbers smaller than 10,000 must be filled to five digits with leading zeros.
- For each requirements artefact, the realisation effort must be defined using one of the three values "high", "medium", or "low".
- Each requirements artefact must be approved by the responsible project leader, the product manager, and the program manager. For each case, the date of approval and the signature have to be recorded.
- For each requirement, the source from which the requirement originates must be unambiguously stated. The valid references to the requirement sources are listed in the document AQ-17-004.
- For each system function, a trigger must be specified. Valid trigger types are "user action", "time event", and "system-internal event".

Checking the acceptance of a requirements artefact

To check the acceptance of a requirements artefact, the relevant acceptance criteria for this artefact should be listed in a checklist (see Section 29.1). This checklist should then be used to verify the fulfilment of the acceptance criteria. For example, the acceptance of a requirements artefact can be checked during an inspection (see Section 28.1). In such an inspection typically both the creators as well as the clients of the artefact participate. The decision regarding whether the requirements artefact is accepted is made based on the evaluation of the defined acceptance criteria as well as the identified shortcomings.

Acceptance Criteria for Requirements Documents

Quality criteria for the requirements document

Acceptance criteria for requirements documents are applied to the requirements document as a whole and not to individual requirements artefacts. Acceptance criteria for requirements documents refine the general documentation rules and guidelines as well as the quality criteria defined for requirements documents (see Section 17.3). They define measurable, quantitative rules, for instance, for checking the completeness of the document. The acceptance of the requirements document depends only

on the fulfilment of the acceptance criteria defined for this document. Therein, an acceptance criterion for the document can include acceptance criteria defined for individual requirements artefacts. Example 16-5 lists some typical acceptance criteria for requirements documents.

Example 16-5: Exemplary acceptance criteria for requirements documents

- At most 3% of the textual goal descriptions documented according to template T-G-003, but excluding goals ranked as "high priority", may still contain gaps. (Note: The gaps must be filled later on in the development process.)
- For the acceptance of the requirements document, 98% of the functional requirements descriptions must have been successfully accepted according to the acceptance criteria for functional requirements (see document F-Acc-12-01).
- Each scenario contained in the requirements document must have been inspected at least one time under consideration of the acceptance criteria for scenarios (checklist CL-S-001). For each scenario for which a major defect or more than three minor defects were detected, a follow-up inspection must have been performed.

16.4.2 Acceptance Criteria for the System

Refinement of functional and quality requirements

Acceptance criteria define under which conditions the client will accept the implemented system or system component (see [IEEE Std 610.12-1990]). During the acceptance test, it is checked whether the system or the system component fulfils all the defined criteria or not. Acceptance criteria for the system specify requirements for the acceptance test and define, for instance:

Coverage criteria

- *Requirements for test case derivation*: In this case, the acceptance criterion defines which coverage criterion is used as well as the minimum coverage to be achieved (e.g. a coverage of 80%; see Chapter 37).

Input–output pairs

- *Definitions of inputs and outputs*: In this case, the acceptance criterion defines the inputs and outputs expected from the system or system component in the form of input–output pairs. Test cases must be created based on these criteria and executed during the acceptance test (see Chapter 37).

We differentiate acceptance criteria for verifying individual functional and quality requirements from acceptance criteria defined for the acceptance of the entire system or a system component.

Acceptance Criteria for Individual Functional and Quality Requirements

Acceptance criteria for individual functional and quality requirements define rules used to test whether the implemented system or component fulfils specific functional

and quality requirements. These acceptance criteria are applied during the acceptance of the system or component. An example of an acceptance criterion for a functional requirement is presented in Example 16-6. Examples for acceptance criteria for a quality requirement are presented in Example 16-7.

Example 16-6: Acceptance criterion for a functional requirement

Requirement R1 specifies a functional property of an elevator control system:

- *R1*: "When the emergency stop button is pushed, the control system must stop the elevator within 1 s."

For this requirement, the following acceptance criterion A1 is defined:

- *Acceptance criterion A1*: The fulfilment of requirement R1 has to be proven by an acceptance test in the real operational environment. The acceptance test must be performed with the maximum payload allowed and at the maximum vertical speed. At least 30 test runs have to be performed. In at least 20 of the 30 test runs, the elevator must stop within 0.9 s. In at most 10 test runs, the system is allowed to take longer than 1 s to stop the evaluator, but not more than 1.5 s.

Example 16-7: Acceptance criteria for a quality requirement

The requirement R142 defines a performance requirement:

- *R142*: The system responds to a user input within 1 s.
- *Acceptance criterion A2.1*: The system shall respond to 98% of all requests within 1 s and to the remaining 2% within 5 s at an average load of 50 user requests per second.
- *Acceptance criterion A2.2*: When 1,000 users are logged on, the log-in process for another user must not take longer than 5 s.

Contribution to requirements validation

Defining acceptance criteria for requirements allows for an objective acceptance test. In addition, when defining acceptance criteria, typically defects in the requirements are uncovered (as during the creation of test artefacts; see Section 29.3). The acceptance criteria for stable, well-understood requirements should thus be defined already during requirements engineering. Besides the early detection of requirements defects, defining acceptance criteria during requirements engineering facilitates early development of test cases. Most importantly, only if the acceptance criteria are defined early can they be considered during system development. Defining acceptance criteria very late in the project, e.g. during acceptance testing, should thus be avoided.

However, a requirement has to be sufficiently understood and stable to justify spending the effort required to define concrete acceptance criteria.

Acceptance Criteria for the Entire System

Joint effect of a set of requirements

Acceptance criteria for the entire system address system properties that result from a set of or even all requirements specified for the system. The acceptance criteria for the entire system can refer to the acceptance criteria defined for individual functional and quality requirements. Example 16-8 describes three typical acceptance criteria.

Example 16-8: Acceptance criteria for the system

- For a successful acceptance test, 98% of all required test cases (see acceptance criteria A1 to A38) must be performed without serious deviations.
- The input–output pairs defined in the files IN-OUT-1 to IN-OUT-12 must be used during testing. The system has to produce the specified outputs in all cases.
- The acceptance test must be performed successfully in the environment defined in the document CONF-001 as well as in the environment defined in the document CONF-002.