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The Inscrutable Jungle of Quality Criteria - How to Formulate Requirements for a Successful Product Development

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Abstract

The steady consideration of requirements during the development of new products remains one of the most difficult and challenging tasks in every development process. Within these considerations, quality criteria are existing for the structured formulation and documentation of requirements in requirements lists. Existing approaches focus on the completeness of requirements during the product development process. But contrarily, the effectiveness and efficiency of product development processes are mainly influenced by a structurally conducted and systematic requirement acquisition and requirements documentation to form a reliable base for the entire development process and to support development of optimised products in special applications.

The paper presents the results of a systematic literature analysis of existing quality criteria for the formulation of requirements. Often, quality criteria are not assigned with precise definitions for a clear conceptual understanding. They allow a large room for interpretation, for which reason they cannot be used as a uniform base for a systematic requirements documentation.

However, quality criteria are partially competitive and even occasionally contradictory. Every developer who is involved in the acquisition and documentation of requirements is lost in the inscrutable jungle of quality criteria. In addition, the quality criteria are unstructured according to their content and formal structure.

Furthermore, the paper offers a systematic and critically reflected reduction of existing quality criteria for the formulation and documentation of requirements that are differentiated according to content and formal structure of requirements. The paper provides a compacted spectrum of quality criteria without synonymously used quality criteria, underpinned with a differentiated conceptual understanding and prioritisation of each relevant quality criterion. Thus, a valuable base for the formally supported requirements documentation in the requirements list is provided.

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Keywords: requirements; quality criteria; formal structure of requirements

1. Breaking new ground through the jungle of quality criteria

Requirements form the initial base in every development process. They guide developers through the development of technical products aligned to the fundamental wishes and expectations of customers that are formalised as requirements in the language of developers [1]. Therefore, requirements describe on the one hand what developers should do, but on the other hand not how they have to do it in order to develop new and innovative products [2]. A clear and systematic task clarification provides the base for a successfully completed product development [3].

Unfortunately, a uniform understanding of how to formulate requirements and how to document requirements does not exist. Misunderstandings and aberrations during the product development process have to be avoided. However, quality criteria exist for the effective formulation of requirements, whereas existing approaches focus only on the completeness of requirements [4].

At this point it seems clear that every developer should be grateful for each quality criterion concerning the formulation and documentation of requirements. Unfortunately, more than one hundred allegedly different quality criteria exist for the documentation of requirements. Even the best developer may be lost in this vast quantity of quality criteria.

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1.1. Benefits by clearing the jungle of quality criteria

Different authors propose a variety of quality criteria for the structured formulation and documentation of requirements. However, fewest quality criteria are subject to a substantive meaning. They are not assigned with precise definitions which allows a large room for interpretation. The current understanding requests the complete fulfilment of each quality criterion to guarantee a qualitatively well formulated and documented requirement. Above all, quality criteria are used synonymously, have overlaps in their contents and are partially contradictory to each other. Therefore, a systematic reduction of existing quality criteria is needed

- to provide a *compacted spectrum* of quality criteria,
- *without synonyms*,
- *without competitive and contradictory meanings,*
- by having a *differentiated conceptual understanding*
- of each *prioritised* quality criterion.

As a result, goal conflicts between requirements are solved much earlier, for which reason the effectiveness and efficiency of product development processes are significantly increased by qualitatively well formulated and documented requirements according to applied quality criteria.

Section 2 presents the results of a systematic literature analysis of existing quality criteria. The section additionally provides a distinction of quality criteria for the formal structure of requirements from quality criteria that are focused on the content of requirements. *Section 3* systematically reduces the huge amount of quality criteria to the most important ones and presents a differentiated conceptual understanding for each quality criterion. The ontological summary of existing quality criteria according to their substantive meaning is based on semantic and linguistic comparisons. This section also contains a prioritisation of the most relevant quality criteria for the documentation of requirements. Conclusions in *Section 4* summarise the main results that are achieved in this paper.

2. An insight into the inscrutable jungle of quality criteria for the documentation of requirements

Quality criteria should support developers during the definition and formulation of requirements. Unfortunately, a huge amount of quality criteria exists in literature. This vast quantity of quality criteria leads to a critical confusion of developers during the formulation and documentation of requirements which is why most requirements are incompletely documented and present in unsuitable patterns. As stated by ROOZENBURG/EEKELS, the documentation of requirements has to be designed itself before anything can be documented [5].

Most authors define different quality criteria for the formulation and documentation of requirements. No developer may be able to incorporate the entirety of quality criteria during the formulation of requirements, regardless of the contradictory and synonymously used quality criteria. The analysis shows that two types of quality criteria have to be differentiated: quality criteria in *form* and *content*.

2.1. Quality criteria for the content of requirements

Table 1 shows each quality criterion according to the respective authors for the documentation of the requirements' content.

Table 1. Quality criteria related to the content of requirements

Quality criterion	CHAKRABARTI [6]	EDER, HOSNEDL [3]	IEEE STD 830-1998 [7]	LINDEMANN [8]	PAHL, BEITZ [9,10]	PONN, LINDEMANN [11]	ROOZENBURG, EEKELS [5]	RUPP & DIE SOPHISTEN [12]	SOMMERVILLE [13]	ULRICH, EPPINGER [14]	VDI GUIDELINE 2221 [15]
accurate		•									
achievable				•							
adequate innovation		•									
ambitious				•							
analysable						•					
clear		•		•					•		
comprehensible					•						
concise						•					
considerable during evaluation						•					
consistent			•					•	•		
continually revised	•										
controlling risks		•									
correct		•	•		•						
current											•
detailed						•					
easy to understand									•		
feasible					•						
measurable										•	
non-redundant							•				
not duplicated		•									
precise										•	•
state of the art		•									
unambiguous		•	•	•	•			•	•	•	
updated	•										
valid							•				
verifiable			•								
without conflict					•						

CHAKRABARTI states that requirements have to be *continually revised* during the entire development process with the aim of an *updated* [6] and *current* [15] requirements documentation. EDER/HOSNEDL stress in their considerations that each requirement in the requirements list should remain an *adequate potential for innovation* of the technical solution while incorporating the *state of the art* with a *controlled risk*