Poster: Challenges with Automotive Test Case Specifications

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ABSTRACT

In the automotive domain standards like ISO 26262 require a structured test process. Test cases are usually derived from requirements and documented in test case specifications. They provide a necessary basis for test implementation and execution. Therefore, test case specifications are a fundamental part of the automotive test process. The aim of this work is to gain insights into the creation and processing of test case specifications from a practitioner's point of view. In order to identify challenges concerning automotive test case specifications, we conducted an explorative case study based on 17 semi-structured interviews at a German OEM and three automotive suppliers. The interviews were transcribed and analyzed qualitatively to identify the challenges. We summarized the challenge to a taxonomy consisting of nine main categories: (1) availability and (2) content-related problems with input artifacts, (3) knowledge-related problems, (4) test case related problems, (5) the test case specification content-related problems, (6) process-related problems, (7) communication-related problems, (8) quality-related problems, and (9) tool-related problems. In general, we noticed that the interviewees were aware of challenges in terms of test case specifications in the automotive domain. Nevertheless, some of the current solutions are not efficient and require a lot of manual work.

CCS CONCEPTS

• **Software and its engineering → Software verification and validation**;

KEYWORDS

Automotive testing, test case specification, challenges

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Innovations in the automotive sector are nowadays mainly realized by software and electronic systems. In order to ensure that software works as expected, testing is an integral part of the automotive development process. Standards like ISO 26262 [1] or Automotive SPICE [25] must be implemented by OEMs and require the documentation of testing activities. Therefore, test case specifications (cf. ISO 29119 [2]) document the set of test cases derived from the test basis (e. g. system or component requirement specifications) for a particular test object [11]. A faultless test case specification is necessary to avoid resulting errors or misinterpretations in subsequent test activities.

In order to improve the quality of automotive test case specifications, the aim of this research is to investigate challenges from a practitioner's point of view in an empirical study. Therefore, the following research question will be answered: *What are the challenges concerning to test case specifications in automotive software testing?* Challenges are suspected in the areas of (C) creating, (P) processing, and (Q) quality aspects of test case specifications.

The research question has not yet been answered comprehensively in literature. In general, challenges are mentioned related to the increasing complexity and heterogeneous nature of software-based systems [9, 12, 17], distributed development of a system [9, 17], huge number of variants and configurations [17, 23], natural language based test cases [14], insufficient tool support [5, 8, 9, 16], and lack of trainings [8, 12]. The need for a test methodology to address challenges associated with the test process has also been stated [17]. However, there exist currently no empirical studies focusing on challenges with respect to automotive test case specifications.

We conducted an explorative case study [18] at an German OEM and three suppliers and collected data from 17 semi-structured interviews. The interviewees were selected based on their involvement in the testing process and their relation to test case specifications. In order to avoid a limited perspective, we made sure that interviewees came from different departments (11 in number), performed different roles in the test process (e.g. manager, test designer, tester) and that they were responsible for different systems to be tested (e.g. exterior light system, central locking system, comfort systems, parking assistance system, or powertrain related systems). We transcribed the interviews and analyzed them qualitatively [19]. Therefore, the data was coded according to the three main coding phases based on Strauss et al. [21].

We identified nine major challenges and created a taxonomy, which is shown in Table 1 together with a mapping of related work. Challenges related to the *availability of input artifacts* (1) concern distributed documents or information, input artifact that do not exist (e.g. test concepts) or are not available in time as well as in a required maturity (e.g. requirement specifications) and missing access or supply of relevant input artifact (e.g. especially in collaboration with suppliers). These challenges occur mainly while creating (C) test case specifications and inhibit test case design. Rudimentary

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Table 1: Taxonomy of Test Case Specification Challenges

Main Challenges	Related Work
1. Availability Problems with Input Artifacts	[13, 14]
2. Content-related Problems with Input Artifacts	[8, 9, 12, 17]
3. Knowledge-related Problems	[12, 14, 17]
4. Test Case related Problems	[8, 12, 14]
5. Test Case Specification Content-related Problems	[9, 17]
6. Process-related Problems	[12, 22]
7. Communication-related Problems	[10]
8. Quality-related Problems	[24]
9. Tool-related Problems	[8, 9, 12, 14, 16]

test concepts were observed as solution in practice. *Content-related problems with input artifacts* (2) concern the lack of requirements clarity, incomplete and conflicting requirements, which lead to re- and miss-interpreting. Moreover, challenges with used templates are included. These challenges have a significant influence on the test design (C) and faults can propagate to test implementation and execution (P). The usage of customized templates were mentioned as a solution. Therefore, we identified some characteristics of a template that are useful for creating test case specifications (e.g. variant handling, managing reusable parts). We identified *knowledge-related problems* (3), which affect all areas (C, P, Q) and roles such as test designers, testers and reviewers. A sufficient knowledge of the system under test, the used test platforms and test policies is required to create, process and review high-quality test cases. *Test case related problems* (4) refer to the phrasing used in test cases and in particular the usage of natural language descriptions. This may affect all areas (C, P, Q) and lead to a lot of manual activities to uniform test cases, misunderstandings and incomplete test cases or require extensive (manual) quality checks. The phrasing used varies depending on the test designer. We detected problems related to an extensive use of abbreviations or insufficient test case descriptions, which lead to ambiguity and misunderstanding during test implementation. We identified a new challenge concerning the correlation between test case description and the target test platform. For instance, there are differences in test case descriptions for a prototype vehicle or a Hardware-in-the-loop (HiL) test system. Methods for documenting and tracing experience-based test cases are still missing. Moreover, we identified typical quality-based problems in test cases related to the changeability and reusability as well as the completeness of test cases, such as missing preconditions and undefined test case meta data. Challenges related to the *test case specification content* (5) are associated with the huge number of variants in the automotive domain. We observed that standard or company-based templates rarely provide solutions for variant handling. As a result, each department develops its own solution and therefore each discipline has its own methods, processes and tools. Interdisciplinary exchange between different departments rarely takes place. *Process-related problems* (6) concern the lack of standards or guidelines and influence the creation (C), while missed change requests mainly occur in the processing (P) of a test case specification (e.g. content of test cases differ from requirements). This is due to poor change management and a lack of traceability management. *Communication-related problems* (7) occur mainly between test designers and testers and therefore they are related to the further processing of a test case specification (P). *Quality-related problems* (8) address quality assessment activities (P) and affect quality aspects (Q). We observed that characteristics of a high-quality test case specification were often not well known to the interviewees or could not be named explicitly. We identified a lack of useful quality metrics for test case specifications, which could support test case specification reviews. *Tool-related problems* (9) were mentioned as an existing problem for various test activities (C, P, Q) such as automating quality assessments especially for test case specifications. Furthermore, we observed that a major part of the creation of a test case specification is still done manually.

We have encountered similar challenges in all four companies as well as in the different departments and assume that these challenges may be similar for other departments and companies in the same environment. There exist significant problems in the creation, further processing and quality assessment of test case specification. Our explorative case study summarizes and categorizes the identified challenges and relates them to related work focusing on test case specifications in the automotive domain.

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