

# Systematic Mapping on Testing Techniques of Non-Functional Requirements for Mobile Applications

\*Obrigatório

## 1 - Involved Researchs

### 1. 1.1 - Data extracted by: \*

*Marcar apenas uma oval.*

☐ Domenico

☐ Misael

☐ Stevão

## 2 - STUDY INFORMATION

### 2. 2.1 - Title \*

Please, report here the title of the study you are analyzing.

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### 3. 2.2 - Authors \*

Please, inform the authors of the study you are about to collect data (Ex: Amalfitano, D., Junior, M. C. and Oliveira, L.B.R.)

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### 4. 2.3 - Year \*

Please, put the year of publication of the study analysed.

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### 5. 2.4 - Country \*

Affiliation country of first author

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### 6. 2.5 - BibTeX reference \*

Please, put the complete reference of the study you are about to extract data. Be sure that the entry has all information about the study.

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**7. 2.6 - Venue \***

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- ☐ Journal
- ☐ Conference
- ☐ Workshop
- ☐ Symposium

**8. 2.7 - Source \***

Please put if the study was conducted by industry, academy or collaboration between industry and academy.

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- ☐ Industry
- ☐ Academy
- ☐ Collaboration

**9. 2.8 - The paper should be excluded \***

Please, write a small description about the study (four to six lines).

*Marque todas que se aplicam.*

- ☐ Yes
- ☐ No

**10. 2.9 - If you answered no to the previous question, please report here the sentences showing the paper addresses NFR testing. If you answered no, please briefly describe why the paper was discarded.**

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## **RQ1 - What are the characteristics of NFR testing approaches used in mobile applications?**

Rationale: in RQ1, we will characterize the NFR testing approaches identified relating the NFR with each NFR testing approach.

Please refer to the definitions reported in the standard and summarized below

### **Performance Efficiency - Compatibility - Usability**

Performance Efficiency	Time-behavior	degree to which the response and processing times and throughput rates of a product or system, when performing its functions, meet requirements.
	Resource Utilization	degree to which the amounts and types of resources used by a product or system, when performing its functions, meet requirements.
	Capacity	degree to which the maximum limits of the product or system, parameter meet requirements.
Compatibility	Co-existence	degree to which a product can perform its required functions efficiently while sharing a common environment and resources with other products, without detrimental impact on any other product.
	Interoperability	degree to which two or more systems, products or components can exchange information and use the information that has been exchanged.
Usability	Appropriateness recognisability	degree to which users can recognize whether a product or system is appropriate for their needs.
	Learnability	degree to which a product or system enables the user to learn how to use it with effectiveness, efficiency in emergency situations.
	Operability	degree to which a product or system is easy to operate, control and appropriate to use.
	User error protection	degree to which a product or system protects users against making errors.
	User interface aesthetics	degree to which a user interface enables pleasing and satisfying interaction for the user.
	Accessibility	degree to which a product or system can be used by people with the widest range of characteristics and capabilities to achieve a specified goal in a specified context of use.

## Reliability - Security - Maintainability

Reliability	Maturity	degree to which a system, product or component meets needs for reliability under normal operation.
	Availability	degree to which a product or system is operational and accessible when required for use.
	Fault tolerance	degree to which a system, product or component operates as intended despite the presence of hardware or software faults.
	Recoverability	degree to which, in the event of an interruption or a failure, a product or system can recover the data directly affected and re-establish the desired state of the system.
Security	Confidentiality	degree to which the prototype ensures that data are accessible only to those authorized to have access.
	Integrity	degree to which a system, product or component prevents unauthorized access to, or modification of, computer programs or data.
	Non-repudiation	degree to which actions or events can be proven to have taken place, so that the events or actions cannot be repudiated later.
	Accountability	degree to which the actions of an entity can be traced uniquely to the entity.
	Authenticity	degree to which the identity of a subject or resource can be proved to be the one claimed.
Maintainability	Modularity	degree to which a system or computer program is composed of discrete components such that a change to one component has minimal impact on other components.
	Reusability	degree to which an asset can be used in more than one system, or in building other assets.
	Analyzability	degree of effectiveness and efficiency with which it is possible to assess the impact on a product or system of an intended change to one or more of its parts, or to diagnose a product for deficiencies or causes of failures, or to identify parts to be modified.
	Modifiability	degree to which a product or system can be effectively and efficiently modified without introducing defects or degrading existing product quality.
	Testability	degree of effectiveness and efficiency with which test criteria can be established for a system, product or component and tests can be performed to determine whether those criteria have been met.

## Portability

Portability	Adaptability	degree to which a product or system can effectively and efficiently be adapted for different or evolving hardware, software or other operational or usage environments.
	Installability	degree of effectiveness and efficiency in which a product or system can be successfully installed and/or uninstalled in a specified environment.
	Replaceability	degree to which a product can replace another specified software product for the same purpose in the same environment.

### 11. 3.1 - Non-functional requirement \*

Please, put the NFR analyzed in the study defined according ISO/IEC 25010.

*Marque todas que se aplicam.*

- ☐ Functional Suitability
- ☐ Performance efficiency
- ☐ Compatibility
- ☐ Usability
- ☐ Reliability
- ☐ Security
- ☐ Maintainability
- ☐ Portability
- ☐ Outro: \_\_\_\_\_

**12. 3.2 - Output produced by each NFR technique cited in the study \***

Please, put the output associated with each NFR cited in the study. For example, if the Security NFR is cited and authors cite faults such as "user data privacy" associated to this NFR, then put: "Security - Data Privacy" or energy consumption log file

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**13. 3.3 - Output produced by each NFR technique cited in the study (extracted sentences from the paper) \***

Please report here the sentences extracted from the paper giving the evidence of what is reported in previous answer

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**14. 3.4 - Input needed by each NFR technique cited in the study \***

Please, put the input artifacts needed by each NFR cited in the study. For example, if they need a model of the application, or the source code, or requirement documents etc.

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**15. 3.5 - Input needed by each NFR technique cited in the study (extracted sentences from the paper) \***

Please report here the sentences extracted from the paper giving the evidence of what is reported in previous answer

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**16. 3.6 - Technique description \***

Please report here a brief description of the technique showing the main steps it relies on, along with the needed input and produced outputs

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**17. 3.7 - Technique description (extracted sentences from the paper) \***

Please report here the sentences extracted from the paper giving the evidence of how the technique works. If you can, please identify and describe the main steps of the technique. If it is possible reporting the inputs and the outputs of each step

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**18. 3.8 - Mobile Operating System \***

Please, put the mobile operating system cited in the study.  
*Marque todas que se aplicam.*

- ☐ Android
- ☐ iOS
- ☐ Windows Phone
- ☐ Symbian
- ☐ Outro: \_\_\_\_\_

**19. 3.9 - Quality metric (sub-characteristic) mentioned in paper \***

Please, put the metric or subcharacteristic of the NFR mentioned in the paper. For example, if the authors proposed a performance testing/verification approach to evaluate the degree to which the response and processing times and throughput rates of a product or system, then put "Performance - Time behavior". If in doubt, check standard 25010. <https://iso25000.com/index.php/en/iso-25000-standards/iso-25010>

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## RQ2 - What is the level of automation and tool support of the approaches for NFRs testing in mobile applications?

Rationale: in RQ2, we will extend the characterisation performed in RQ1. Therefore, we will establish a relationship between NFR, the NFR testing approach and the automation level of the approach.

**20. 4.1 - What is the automation degree of the proposed testing technique \***

If we think a testing process generally composed by three testing activities, i.e. test case generation, test case execution, and evaluation of the results. We aim to extract data showing how much the proposed testing technique is automated or not.  
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- ☐ Fully Automated
- ☐ Fully Manual
- ☐ Hybrid (automated but manual intervention is needed)
- ☐ Outro: \_\_\_\_\_

**21. 4.2 - Automation degree of the proposed testing technique (extracted sentences from the paper) \***

Please, report here sentences extracted from the paper giving the evidence about the previous answer

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**22. 4.3 - Does the paper present a tool supporting the proposed technique? \***

Please, report if the study describe some support tool. Also, you must describe If the support tool is a free, open source or commercial tool.

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☐ Yes

☐ No

**23. 4.3.1 - If yes, is the tool freely downloadable?**

*Marque todas que se aplicam.*

☐ Yes (source code)

☐ Yes (executable tool)

☐ No, the tool can not be downloaded

**RQ3 - How these techniques have been evaluated in practice?**

Rationale: in RQ3, we will evaluate how identified approaches are evaluated in the context of mobile applications.

**24. 5.1 - What type of experimental or empirical method is conducted? \***

The options were set according to the Zannier [et.al.](#) (On the Success of Empirical Studies in the International Conference on Software Engineering) and Wholin et. al (Experimentation on Software Engineering) studies. Please, check the description of each type of experimental or empirical method.

*Marque todas que se aplicam.*

- ☐ Survey: system for collecting information from or about people to describe, compare or explain their knowledge, attitudes and behavior. Structured or unstructured questions given to participants.
- ☐ Experiment: empirical enquiry that manipulates one factor or variable of the studied setting. Experiments are mostly done in a laboratory environment, which provides a high level of control. When experimenting, subjects are assigned to different treatments at random. The objective is to manipulate one or more variables and control all other variables at fixed levels. The effect of the manipulation is measured, and based on this a statistical analysis can be performed. In cases where it is impossible to randomly assign treatments to subjects, we may use quasi-experiments.
- ☐ Quasi Experiment: empirical enquiry similar to an experiment, where the assignment of treatments to subjects cannot be based on randomization, but emerges from the characteristics of the subjects or objects themselves. One or more of points in Controlled Experiment are missing.
- ☐ Case Study: empirical enquiry that draws on multiple sources of evidence to investigate one instance (or a small number of instances) of a contemporary software engineering phenomenon within its real-life context, especially when the boundary between phenomenon and context cannot be clearly specified.
- ☐ Experience Report: all of the following exist = Retrospective. No propositions (generally). Does not necessarily answer how or why. Often includes lessons learned.
- ☐ Application example or toy example: authors describing an application and provide an example to assist in the description, but the example is "used to validate" or "evaluate" as far as the authors suggest.
- ☐ Qualitative Analysis: provided some qualitative, textual, opinion-oriented evaluation. E.g. compare and contrast, oral discussion of advantages and disadvantages.
- ☐ Outro: \_\_\_\_\_

**25. 5.2 - Types of experimental evaluation methods (extracted sentences from the paper) \***

Please, report here sentences extracted from the paper giving the evidence about the previous answer

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**26. 5.3 - Technology readiness levels (TRL) \***

Technology Readiness Levels (TRL) is a systematic, metrics-based process that assesses the maturity of, and the risk associated with, critical technologies under development. It is a commonly accepted approach used in a number of industry and government organizations to assess the maturity of a technology (e.g., device, material, component, process, etc.) on an entire scale - from its invention to commercialization and wide-scale application. This RQ explores how primary studies evaluated the NFRs that were proposed for mobile apps. Please, put the Technology readiness levels (TRL) of approach proposed. The options were set according to the Garcés, L. et. al. (Quality attributes and quality models for ambient assisted living software systems: A systematic mapping)

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- ☐ L0 - the technology/approach was not assessed.
- ☐ L1 - the feasibility of the technology/approach was demonstrated using application examples.
- ☐ L2 - the technology/approach was qualitatively evaluated by experts.
- ☐ L3 - controlled experiments in the laboratory were conducted for assessing the technology/approach.
- ☐ L4 - the technology/approach was applied in industrial case studies.
- ☐ L5 - the technology/approach was assessed during industrial practice.
- ☐ Not evidence.
- ☐ Outro: \_\_\_\_\_

**27. 5.4 - Technology readiness levels (TRL) (extracted sentences from the paper) \***

Please, report here sentences extracted from the paper giving the evidence about the previous answer

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