Usability Evaluation of Requirement Collaboration Features in Requirements Management Tools

Oana Rotaru[1,2][a], Silviu Vert[1][b] and Radu Vasiu[1][c]

[1]*Communications Department, Politehnica University of Timişoara, Timişoara, Romania*
[2]*Continental Autonomous Mobility, Timişoara, Romania*

Keywords: Requirements Management Tool (RM Tool), Requirements Engineering, DOORS NG (DOORS next Generation), Usability, Evaluation, User Testing, Focus Group, SUS.

Abstract: In the automotive industry, system requirements, derived from environmental contexts and project goals, evolve from abstract concepts to detailed specifications and of course, increase in complexity. This complexity continues into the project's design, implementation, and integration stages, highlighting the importance of robust, tool-supported Requirements Management (RM). The Requirements Management tools(RMT) are characterized by specific features meant to facilitate the processes, which also lead to complex user interfaces used by requirements engineers and managers, developers, testers. This paper presents the usability evaluation results of the collaboration features of a Requirements Management Tool, DOORS Next Generation (DNG), recently introduced in an automotive company department.

1 INTRODUCTION

The automotive industry is at the forefront of technological advancement and innovation in its pursuit of autonomous vehicles (Botezatu et al., 2024). This evolution exponentially increases the complexity of systems and technologies, necessitating exact standards for safety, performance, and quality. In the dynamic environment of Advanced Driver Assistance Systems (ADAS), precisely writing, managing, and modifying requirements is a crucial process, though it can sometimes become quite challenging (Ågren et al., 2019; Nidamanuri et al., 2021).

Throughout all stages of the ADAS process, from inception to integration, requirements management (RM) plays a vital role in navigating task complexity. In this context, RM tools are indispensable for supporting these processes, see Figure 1. As a summarization, the features required for a RM tool must support requirements activities like: elicitation, analysis of requirements, specification, modelling, verification and validation, traceability, collaboration and global software development (Carrillo et al., 2015; Heyn et al., 2021).

---

[a] https://orcid.org/0000-0003-0550-6871
[b] https://orcid.org/0000-0003-2394-4859
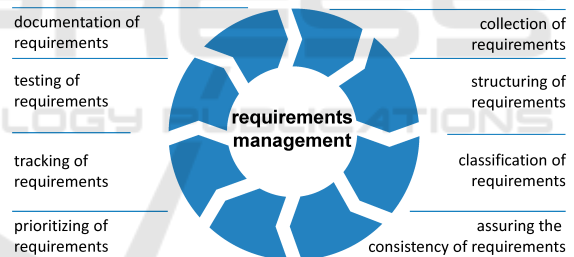[c] https://orcid.org/0000-0003-1185-1997

Figure 1: RM process cycle (Holder et al., 2017).

In terms of Requirements Management Tools (RMT) used in the industry, one of the most common is DOORS Next Generation (DNG), which runs on the IBM Rational Jazz platform. The tool includes a server application and a web client, together enabling the definition, management, and reporting of requirements (IBM Documentation, 2022).

Usability also plays a crucial role when it comes to RMT and the multitude of complex activities specified and performed using them. The main users are requirement engineers and managers, but also developers, project managers and validation engineers. In this case, a user friendly interface not only enhances the efficiency, but also ensures a more accurate use of the tools in the automotive industry (Körber et al., 2013; Rotaru et al., 2024).

In the field of RM, significant efforts have been made to establish a systematic and adaptable framework. (Hoffmann et al., 2004) provides a comprehensive catalog of requirements for RMTs, categorizing key features relevant to the automotive, aerospace, and defense industries. The purpose of the study is to assist users in comparing and selecting the appropriate RMT based on their needs and to guide tool providers in future development. The collaboration features highlighted in this paper are also discussed in the following chapter of the current paper.

A notable and related study in the area of traceability tool usability focuses on the Capra tool (Swart, 2016), which enables the creation of trace links between multiple artifacts. (Skytt and Nersing, 2017) evaluates the usability of the traceability management tool through remote user testing. One of the study's goals was to categorize the usability issues identified to suggest improvements for the tool's development. The authors identified 16 usability issues, with only 50% of participants successfully completing the tasks during the user testing session.

This study aims to present an evaluation of the usability of DNG with the objective of identifying potential usability issues. The evaluation emphasizes the tool's collaboration features, with participants drawn from employees of an automotive company.

One contribution our study aims to provide is the optimized use of DNG. By evaluating the tool's collaboration features, the study can guide businesses and requirements teams in maximizing the tool's effectiveness, potentially uncovering hidden features or best practices that enhance efficiency.

Additionally, our study seeks to support the development of targeted training materials or onboarding processes within companies, ensuring that new users can quickly learn and leverage the tool's full capabilities.

2 THEORETICAL CONCEPTS

2.1 Collaboration Features of RM Tools

Requirements Engineering and Management is not only the process of identifying and describing requirements, but also a process of supporting an efficient communication of the requirements among different stakeholders (Chazette et al., 2022).

When the complexity of a project grows and the requirements become more sophisticated, the RM activities must be accompanied by a systematic tool capable to support them (Hoffmann et al., 2004). Some of the basic tasks performed by the users of

a RMT include creating and editing artifacts, importing/exporting artifacts, maintaining of traceability, review of requirements and generating reports (Hoffmann et al., 2004).

According to (De Gea et al., 2012) to streamline the entire requirements process, the RMT are fitted with various features that can be classified in the following categories:

- Requirements Traceability feature – creation and management of traceability links;

- Reporting and Visualization – capability to customize reporting templates, creating of dashboards, visual representations of requirement relationship and dependencies;

- Customization and Configuration – customization and configurations options, personal dashboards of views;

- Integration with External tools – integration capabilities with other development or testing tools;

- User Interface Design – intuitiveness of navigation, clarity of presented information;

- Mobile and Remote access – use of the tool remotely or on mobile devices and of course;

- Collaboration and Communication feature – real-time collaboration, commenting and feedback mechanisms, version control, notification systems

Examples of collaboration features refer to: real-time editing (multiple users editing the same artifacts simultaneously), commenting/discussion forums, notification systems, user mentions and tagging, task assignment and tracking, version control /comparison, workflows and approval process collaboration during reviews, history of artifacts (Lang and Duggan, 2001).

Particularly on DNG, the tool offers: real-time editing, commenting, tagging and mentioning other users, task assignment and tracking, version control, and history tracking for artifacts. It also integrates a notification system (IBM Documentation, 2023).

2.2 Usability

Usability measures how easily one product is used, in a specific context by a specific user belonging from a target user group. The aim of a usability evaluation is to observe how easily a product is used based on these conditions, in order to accomplish a specific goal in an efficient way (The Interaction Design Foundation,).

The evaluation methods are various and, for our study, the methods employed were User Testing with Think-Aloud Protocol, Focus Group and the System Usability Scale Questionnaire (SUS) questionnaire (Brooke et al., 1996).

According to (Bastien, 2010), one of the most used methods is the User Testing, which involves real users testing the product, with tasks performed in multiple scenarios and recorded for a later analysis. During the evaluation, metrics like task completion time, completion rate and error types are documented. The evaluation usually takes place in a specialized laboratory, equipped with recording devices and the session involves observers, a facilitator, and a moderator.

Another technique used in the usability evaluation is the Think-Aloud Protocol, which encourages participants to verbalize their thoughts while performing the given tasks, during the user testing session. Also during this time, the researchers document the verbalized thoughts for afterwards analysis (Bastien, 2010).

Focus group is an additional method used for usability evaluation, which was also applied in our study. It has been demonstrated as an effective strategy for gathering individuals with the same backgrounds or experiences to discuss a specific topic. The moderator leads the group of participants, introducing subjects for conversation and encouraging lively discussions among the group members (Mishra, 2016).

The System Usability Scale Questionnaire, knows as SUS, is also an instrument used for usability evaluation and it is the most frequently used for usability measurements. The survey consists of 10 statements and the participants are asked to rate their perception of agreement/disagreement on each one. Though SUS is a standardized questionnaire, it offers ease of customization to suit specific products under test like in (Rotaru et al., 2020; Vert et al., 2021; Szekely et al., 2023).

3 EVALUATION/RESEARCH METHODOLOGY

As mentioned before, the tool evaluated was DNG 7.0.2 (current version used by the company), a RMT commonly used in automotive sector. Due to internal confidentiality reasons, a playground area was created by the authors for the user testing session.

3.1 Participants

For the study, 10 participants were engaged. All the participants were at the first encounter with the DNG tool, 5 of them having prior experience with a similar tool used in the company.

The demographic profile of the usability evaluation participants is illustrated in Figure 2. The profile

Figure 2: Participant Demographics and Experience.

is diverse and well-balanced across several criteria:

- Gender – the participants are equally divided between 5 females (F) and 5 males (M), forming a gender balanced group.

- Age – The age distribution was spread across three groups with 5 participants in the 18-26 range, two participants in the 26-35 range and three participants in the 35-50 range. This mix of ages represents a large spectrum of viewpoints and potentially different levels of technological familiarity or expectations.

- Profession/position in the company – The background of the participants varies, including five interns, three requirements engineers (RE) or requirements managers (RM) and two quality engineers (QA). This diversity in roles ensures that the evaluation includes perspectives from different roles within the company.

- Prior experience in similar tools – Half of the participants had experience with IBM Rational DOORS (DOORS), a tool similar to the one being evaluated. This experience may have an influence on their expectations and their ability to navigate the new tool.

- New in evaluated tool – All 10 participants were at their first encounter with DNG. This provides a clean slate for assessing the usability of the tool with no other prior biases.

We can conclude that the demographic profile offers a balanced and varied perspective that covers different genders, age groups, professional roles, and experience levels. This diversity is important in obtain-

ing comprehensive results of the usability of the evaluated tool, DNG.

3.2 Procedure

The main usability evaluation method used in our study was the User Testing (Rubin and Chisnell, 2011). It was organized remotely, via Microsoft Teams, through separate sessions with every participant.
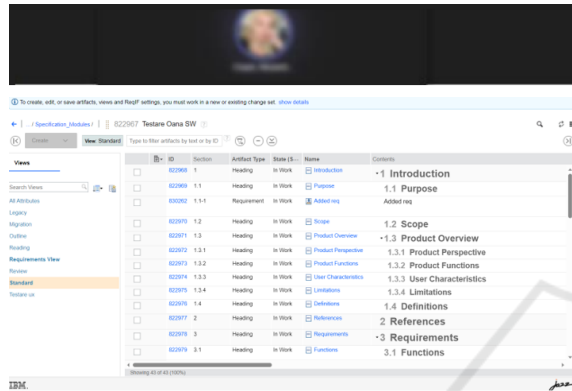

Figure 3: Participant during user testing session.

Figure 3 illustrates a typical user testing session, with one of the participants performing tasks in DNG.

At the beginning, the participants filled out a survey with questions on details of their professional experience with requirements management tools and their interest of this kind of platforms. The participants with previous experience in similar tools were asked about their favorite features and their expectations upon the interaction with DNG.

The participants were handed 4 tasks to perform in DNG and the tasks were focused on the interaction with the collaboration features. During the user testing, the participants were encouraged to think aloud while performing the tasks (McDonald et al., 2012).

The task were as following:

- Task 1: Finding comments column and adding a comment;

- Task 2: Informing a specific user about changes from a comment;

- Task 3: Finding and comparing the last two baselines;

- Task 4: Viewing the history of a specific artifact;

The tasks which were handed to the participants involved basic routine activities concerning collaboration within RMT, like finding the comments column and how to add a comment for an artifact, informing a certain user about the changes specified in one

comment, finding and comparing two baselines, and tracking the history for one artifact.

While creating these tasks, the authors incorporated several key collaboration features essential for an RMT. These included: the ability to comment; notification systems and user tagging capabilities; version control; maintaining a history and audit trail.

Once the tasks were completed, we applied the focus group method with the participants. The objective was to obtain their feedback regarding their interaction with the new tool's collaborative features, and to understand the anticipations formed prior to the user testing session, particularly from participants who had prior experience with DOORS.

In conclusion, after engaging the participants with the focus group method during the usability evaluation, they were requested to fill out the SUS questionnaire, reflecting on their experience.

4 EVALUATION RESULTS

As previously mentioned, the authors gathered results from the usability evaluation of DNG involving 10 participants, interacting for the first time with the platform, only half of them having prior experience with another similar tool.

4.1 User Testing Results

One of the main usability issues found by the participants during the user testing sessions refers to the action of finding where the baselines of the document can be found and compare the last two baselines – this was the third task given. The participants were asked to compare the last two baselines, but the task was completed only by 30% of participants. When it comes to RMT, baseline refers to the process of defining stable points in the life-cycle of a project and practically a baseline can be considered a snapshot of the project requirements at a particular point in time (Jama Software, 2022). It is an important collaboration feature of a RMT, for providing clear deliverable tracking and, also, for progress measurements.

While performing this task, the participants expected to find this functionality next to the table view of the requirements and not as part of the general configuration tab.

Figure 4 illustrates the table view of the participants visible during the user testing session, with the general configuration tab in the upper right corner of the screen.

Another possible usability issue found pertains to the action of locating the comments column and
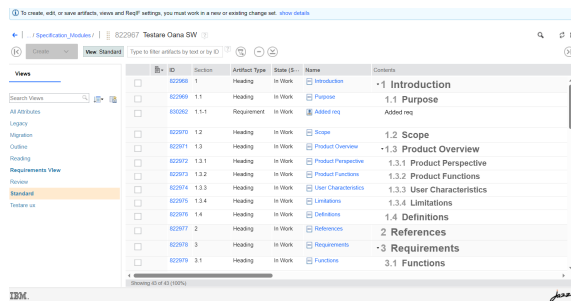
Figure 4: Starting view of participant during the evaluation.

adding a comment. Two participants expressed dissatisfaction with the low visibility of the icon, as they were expecting to see the attribute name of the comments, instead. We consider this a minor usability issue of our study, as only a very small number of participants voiced displeasure to it. In Figure 5 illustrates the comments column through the icon mentioned before.
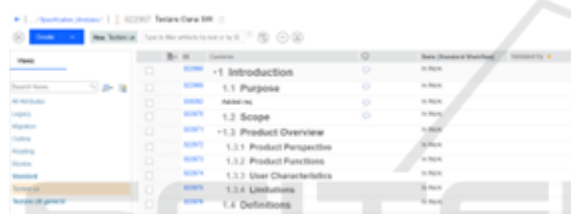

Figure 5: Comments column as part of the participants view.

A possible minor usability challenge observed during the user testing sessions is also regarding the capability of informing specific users while creating comments on artifacts – 30% participants didn't complete this task. However, the remaining 70% participants voiced satisfaction with this feature, finding it valuable during requirements reviews. In Figure 6, there can be seen the section of comments creating with the enabled button for selecting the needed users.

Another minor usability issue discovered during the user testing session of DNG involves the action of finding the history track for one artifact. Most users successfully completed the task, only 30% of them encountering difficulties. The remaining participants expressed their satisfaction for completing this action fast, only by right-clicking on the specific artifact and opening the artifact.

During the user testing sessions, we identified several appreciated aspects of the RMT. Notably, the participants valued the flexibility in performing certain actions, such as three different ways to add comments and multiple approaches to track the history of specific artifacts.

Figure 6: Comment creating section from DNG.

Another feature that gained approval by 70% participants was the extensive range of actions accessible through right-clicking on the artifacts. While some of these actions were not specifically requested during the evaluation, participants still observed and appreciated them. These include capabilities like editing attributes, creating different types of links, inserting new artifacts, copying/removing artifacts and, obviously as they were requested in the tasks, adding comments and tracking the history of an individual artifact.

Table 1 provides a concentrated overview of the average time spent on each task along with the corresponding average completion rates. As it can be observed, the results from the usability evaluation reveal varying levels of efficiency and effectiveness on the given tasks.

Table 1: Success overview per Task (N = 10).

	Avg. Time (min)	Avg. Completion Rate (%)
Task 1	0.7	90
Task 2	0.8	60
Task 3	1.8	47.5
Task 4	0.8	85

The first task implying finding the comments column and adding one comment has a high completion rate of 90% and the lowest average time taken, 0.7 minutes, indicating a good interaction and usability.

The second task related to informing a user about the changes specified in the comment, however, has a lower completion rate of 60% with an average time of 0.8 minutes, suggesting possible challenges for this kind of action in DNG.

The third task – finding and comparing the last two baselines – was the most time consuming, at 1.8

minutes, with a completion rate of only 47.5%, highlighting significant usability issues.

The last task – finding the history for a certain artifact – showed a better performance with an 85% completion rate and an average time of 0.8 minutes.

4.2 Focus Group Results

After the user testing session, the group of participants was gathered and we applied the focus group method.

The participants with prior experience in the similar tool voiced their concerns about the streaming/global configuration features of the new tool used. Specifically, the tasks of finding and comparing baselines involved accessing the configuration tab, which was totally unfamiliar to them. Unlike DNG, the previously used tool IBM Rational DOORS didn't offer the possibility to create baselines on any stream; the baselines were created only on the requirements modules.

This part was also challenging for the participants with no prior experience, who expected this action to be more highly visible near the table view of the requirements.

As also previously mentioned before, the participants expressed their satisfaction on the multiple ways to add comments or tracking the history of specific artifacts, even though these actions also generated confusion for two and three participants.

The ability to inform specific users about changes made to requirements through the RMT was highly appreciated by the participants. However, this action proved to be more challenging for new users lacking prior experience with similar tools. Those who had experience with IBM Rational DOORS found this function valuable and had no difficulty executing the requested task, considering it highly visible and recognizing it as a useful collaboration feature for their work activities.

To sum up, the participants generally regarded the collaboration features of this RMT as user-friendly, memorable for future interactions with the platform, quite consistent and flexible due to multiple ways of performing some actions. These aspects of one RMT enhance the requirements process and facilitates the collaboration among the requirements project engineers and managers.

4.3 SUS Score

After the user testing session, based on their firsthand interaction on DNG, participants were asked to fill out a post-session questionnaire, the SUS questionnaire.

The survey consists of 10 statements and the participants are required to rate their perception of agreement or disagreement on each one. Half of the statements are framed positively, half of them negatively (Will, 2017).

The collaboration features of DNG obtained a SUS score of 69.25 in this user testing session. Interpreting this score judging on SUS ratings (Will, 2017), it corresponds to a "B" grade and is categorized as a "Good" evaluation.

In the context of usability evaluation for an RMT, the focus was on testing collaboration features. This resulted in a SUS score that indicates several aspects:

- User satisfaction.
- Effective collaboration features.
- User-friendly interface: the tool proved to be intuitive for the users.
- Room for improvement: while "Good" reflects positivity, there is still room for enhancement.
- Potential for long-term use: the tool is likely to be used in future endeavors, from the collaboration perspective.

5 CONCLUSIONS

In our study, the primary objective was to spotlight the major usability problems arising from the use of DNG, a RMT, recently introduced in an automotive company department. The study was conducted with 10 participants, with diverse experience and expertise, who actively took part in the user testing session, followed by the focus group method and the completion of a SUS questionnaire.

Our findings reveal the following usability issues:

- Version control and comparison: The most significant challenge encountered by the users was to find and compare the last two baselines of a requirements module. This task, integral to the version control and comparison collaboration feature proved itself as the most time consuming and the most daunting.
- Commenting and Visibility: A secondary minor usability challenge pertained to the comments section's visibility. However, the evaluation of the commenting mechanism indicated effective usability, as suggested by its high completion rate.
- Notification & tagging, history: Both these two are considered crucial collaboration features for RMTs, as they can facilitate efficient communication and streamline progress measurements of

requirements work. In this study, the actions of user notification and finding the history of an artifact were executed quickly, but the history tracking proved to be more user-friendly, reflecting a higher completion rate compared to the users informing action.

Contrary to the identified usability issues, there are many points from the usability evaluation which indicate positive outcomes for the collaboration features of DNG RMT. These can be summed up as:

- Multi-modal commenting abilities.

- Comprehensive artifact history.

- Efficient user notification and tagging mechanisms.

- A user-centric interface design, which facilitates ease of recall and navigation.

Among these, the SUS score of 69.25 indicates a "Good" adjective rating, which can mean the overall satisfaction of the users during the interaction, but also room for improvements.

Potential constraints of the study may arise from the limited number of tasks assigned during the user testing session. With only 4 tasks provided to the participants, a more comprehensive understanding of usability issues might have been achieved with an extended set of scenarios.

Another possible limitation of our study can be caused by the assessment of only one RMT, DNG - our findings might not be universally applicable to other RMTs.

For future research in this field, we aim to expand this study to the remaining collaboration features like real-time collaboration (when multiple users can view and edit requirement simultaneously), file attachment and sharing or approval workflows for the requirements reviews capabilities.

By evaluating the requirements collaboration features of DNG, one purpose of the authors is to optimize the use of the tool. Also, our study could guide the software development teams/requirements teams on how to best utilize the tool, potentially bringing to the surface hidden features or best practices that can improve efficiency of work. The study also might be a starting point of evaluation criteria establishment in the context of these platforms.

As we continue to explore the field in future research, we plan to extend the usability evaluation to cover other specific features of Requirements Management Tools, features like Requirements Traceability, Reporting and Visualization, Requirements Prioritization and Planning features, as well as evaluating these features on other similar RMTs. This extended study can lead to a deeper understanding of usability

challenges niched on RM specific features and will provide valuable insights for the requirements management tools field. Additionally, we aim to extend the research to a larger participant pool, in order to obtain more robust and comprehensive analysis in the future.

ACKNOWLEDGEMENTS

REFERENCES

Ågren, S. M., Knauss, E., Heldal, R., Pelliccione, P., Malmqvist, G., and Bodén, J. (2019). The impact of requirements on systems development speed: a multiple-case study in automotive. *Requirements Engineering*, 24:315–340.

Bastien, J. C. (2010). Usability testing: a review of some methodological and technical aspects of the method. *International journal of medical informatics*, 79(4):e18–e23.

Botezatu, A.-P., Burlacu, A., and Orhei, C. (2024). A review of deep learning advancements in road analysis for autonomous driving. *Applied Sciences*, 14(11):4705.

Brooke, J. et al. (1996). Sus-a quick and dirty usability scale. *Usability evaluation in industry*, 189(194):4–7.

Carrillo, d. G. J. M., Nicolás, J., Fernández, A. J. L., Toval, A., Ebert, C., and Vizcaíno, A. (2015). Commonalities and differences between requirements engineering tools: A quantitative approach. *Computer Science and Information Systems*, 12(1):257–288.

Chazette, L., Brunotte, W., and Speith, T. (2022). Explainable software systems: from requirements analysis to system evaluation. *Requirements Engineering*, 27(4):457–487.

De Gea, J. M. C., Nicolás, J., Alemán, J. L. F., Toval, A., Ebert, C., and Vizcaíno, A. (2012). Requirements engineering tools: Capabilities, survey and assessment. *Information and Software Technology*, 54(10):1142–1157.

Heyn, H.-M., Knauss, E., Muhammad, A. P., Eriksson, O., Linder, J., Subbiah, P., Pradhan, S. K., and Tungal, S. (2021). Requirement engineering challenges for ai-intense systems development. In *2021 IEEE/ACM 1st Workshop on AI Engineering-Software Engineering for AI (WAIN)*, pages 89–96. IEEE.

Hoffmann, M., Kuhn, N., Weber, M., and Bittner, M. (2004). Requirements for requirements management tools. In *Proceedings. 12th IEEE International Requirements Engineering Conference, 2004.*, pages 301–308. IEEE.

Holder, K., Zech, A., Ramsaier, M., Stetter, R., Niedermeier, H.-P., Rudolph, S., and Till, M. (2017). Model-based requirements management in gear systems design based on graph-based design languages. *Applied Sciences*, 7(11):1112.

IBM Documentation (2022). Ibm documentation. https://www.ibm.com/docs/en/engineering-lifecycle-management-suite/lifecycle-management/7.0.0?topic=next-comparison-doors-doors. (accessed Jun. 21, 2023).

IBM Documentation (2023). Ibm documentation. https://www.ibm.com/docs/en/engineering-lifecycle-management-suite/doors/9.7.2?topic=access-viewing-adding-comments-discussions. (accessed Jun. 21, 2023).

Jama Software (2022). Defining and implementing a requirements baseline. https://www.jamasoftware.com/requirements-management-guide/requirements-gathering-and-management-processes/defining-and-implementing-requirements-baselines. (accessed Aug. 03, 2023).

Körber, M., Eichinger, A., Bengler, K., and Olaverri-Monreal, C. (2013). User experience evaluation in an automotive context. In *2013 IEEE Intelligent Vehicles Symposium Workshops (IV Workshops)*, pages 13–18. IEEE.

Lang, M. and Duggan, J. (2001). A tool to support collaborative software requirements management. *Requirements Engineering*, 6:161–172.

McDonald, S., Edwards, H. M., and Zhao, T. (2012). Exploring think-alouds in usability testing: An international survey. *IEEE Transactions on Professional Communication*, 55(1):2–19.

Mishra, L. (2016). Focus group discussion in qualitative research. *TechnoLearn: An International Journal of Educational Technology*, 6(1):1–5.

Nidamanuri, J., Nibhanupudi, C., Assfalg, R., and Venkataraman, H. (2021). A progressive review: Emerging technologies for adas driven solutions. *IEEE Transactions on Intelligent Vehicles*, 7(2):326–341.

Rotaru, O., Vert, S., and Vasiu, R. (2024). Switching from doors to doors next generation. identifying the main usability issues. a case study. In *International Congress on Information and Communication Technology*, pages 261–276. Springer.

Rotaru, O. A., Vert, S., Vasiu, R., and Andone, D. (2020). Standardised questionnaires in usability evaluation. applying standardised usability questionnaires in digital products evaluation. In *International Conference on Information and Software Technologies*, pages 39–48. Springer.

Rubin, J. and Chisnell, D. (2011). *Handbook of usability testing: How to plan, design, and conduct effective tests*. John Wiley & Sons.

Skytt, P. and Nersing, T. (2017). Usability study of a traceability management tool. Master's thesis, University of Gothenburg.

Swart, S. (2016). Eclipse capra. https://projects.eclipse.org/projects/modeling.capra. projects.eclipse.org (accessed Sep. 01, 2023).

Szekely, D., Vert, S., Rotaru, O., and Andone, D. (2023). Usability evaluation with eye tracking: The case of a mobile augmented reality application with historical images for urban cultural heritage. *Heritage*, 6(3):3256–3270.

The Interaction Design Foundation. What is usability? https://www.interaction-design.org/literature/topics/usability. (accessed Jun. 26, 2023).

Vert, S., Andone, D., Ternauciuc, A., Mihaescu, V., Rotaru, O., Mocofan, M., Orhei, C., and Vasiu, R. (2021). User evaluation of a multi-platform digital storytelling concept for cultural heritage. *Mathematics*, 9(21):2678.

Will, T. (2017). Measuring and interpreting system usability scale (sus). https://uiuxtrend.com/measuring-system-usability-scale-sus/. UIUX Trend (accessed Jul. 07, 2023).