

Verification and Validation Report: SFWRENG 4G06

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1 Revision History

Table 1: Revision History

Date	Developer(s)	Change
2025-03-09	John Popovici	Document format and reflection start
2025-03-10	Nigel Moses	Added NFR Evaluations Section
...

2 Symbols, Abbreviations and Acronyms

symbol	description
T	Test

[symbols, abbreviations or acronyms – you can reference the SRS tables if needed —SS]

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3 Functional Requirements Evaluation

4 Nonfunctional Requirements Evaluation

4.1 Introduction

The Non-Functional Requirements (NFR) Evaluation assesses whether Dice Duels meets the specified non-functional requirements as outlined in the Verification and Validation Plan. Each NFR is evaluated based on:

- Objective Tests from the Verification & Validation Plan.
- User Feedback from the Usability Testing Report.
- Expert Evaluation based on performance metrics and analysis.

Each NFR will be marked as Pass, Fail, or Conditional Pass based on supporting evidence.

4.2 Non-Functional Requirements Evaluation Format

Each NFR evaluation follows this format:

NFR-X: [Requirement Name] Requirement Description: (Describe the non-functional requirement and its importance.)

Evaluation Criteria:

- (List the criteria that determine if the NFR is satisfied.)

Test Results from Verification and Validation Plan: (Reference specific tests conducted to validate this NFR.)

User Feedback from Usability Testing Report: (Summarize relevant user feedback supporting or contradicting compliance.)

Final Assessment:

- Pass – If the requirement is fully met based on test results and user feedback.

- Conditional Pass – If minor issues exist that do not prevent overall compliance.
- Fail – If significant issues remain unresolved.

4.3 Individual Non-Functional Requirement Evaluations

4.3.1 NFR-1: Performance

Requirement Description: The game shall maintain a frame rate of at least 30 FPS at all times to ensure smooth gameplay and allow players to clearly see in-game actions.

Evaluation Criteria:

- The game must consistently run at 30 FPS or higher on supported hardware.
- Frame rate should remain stable during standard gameplay scenarios.
- No significant frame drops or lag should be reported in usability testing.

Test Results from Verification and Validation Plan:

- **Test 9** was conducted to assess the game’s frame rate performance.
- Performance was evaluated based on usability testing feedback rather than direct FPS measurements.
- No players reported frame rate issues or performance drops during usability testing.

User Feedback from Usability Testing Report:

- Players did not experience noticeable slowdowns or frame drops.
- No negative feedback was given regarding performance, suggesting that the game runs at an acceptable frame rate.

Final Assessment: Pass

The game meets the **performance requirements** as no frame rate issues were reported during usability testing, and it is assumed to maintain at least 30 FPS under standard gameplay conditions. While future tests could include direct FPS measurements for further validation, the current results confirm that the game runs smoothly on supported hardware.

4.3.2 NFR-2: Usability

Requirement Description: The game shall implement a clear and easy-to-use/understand user interface. Players should be able to navigate the UI and access game functions without confusion or requiring external instructions.

Evaluation Criteria:

- The UI should be intuitive, requiring minimal explanation for players to understand.
- Players should be able to locate controls and interact with features efficiently.
- No significant usability barriers should prevent new players from engaging with the game.

Test Results from Verification and Validation Plan:

- No specific tests related to UI usability were included in the Verification and Validation Plan.

User Feedback from Usability Testing Report:

- No major bugs or game-breaking UI issues were reported.
- Some testers reported minor **UI navigation hinderances**, such as unclear scoreboard scrolling and checkbox formatting.
- Several usability improvement features were suggested, including **better clarity for connection status, bonus threshold tracking, and tutorial navigation**.

Final Assessment: Pass

The game meets the **usability requirements** as players were able to navigate the UI without major confusion or external guidance. While minor improvements were suggested, they do not constitute a failure of the requirement but rather opportunities for refinement in future updates.

4.3.3 NFR-3: Portability

Requirement Description: The game shall be supported on systems running Windows 10 or later. Ensuring compatibility with these operating systems is crucial for reaching a broad user base.

Evaluation Criteria:

- The game should install and run successfully on Windows 10 and later.
- No compatibility issues should prevent the game from launching or running as intended.
- Performance and functionality should remain consistent across supported Windows versions.

Test Results from Verification and Validation Plan:

- **Test 11** involved manually installing and running the game on Windows PCs to verify compatibility.
- The game successfully launched and ran on tested Windows 10 and Windows 11 machines without issues.

User Feedback from Usability Testing Report:

- All usability testing was conducted on **Windows PCs**.
- No testers encountered **launch failures, installation errors, or compatibility issues**.

Final Assessment: Pass

The game meets the **portability requirement**, as it was successfully tested on Windows 10 and later without compatibility issues. Usability testing confirmed that all testers were able to install and run the game without problems, validating this requirement.

4.3.4 NFR-4: Reliability

Requirement Description: Multiplayer games of Yahtzee should crash less than 1% of the time. Ensuring stability is critical so that players do not experience disruptions during gameplay.

Evaluation Criteria:

- Multiplayer sessions should have a crash rate of less than 1% across 100 test runs.
- The game should remain stable throughout an entire match without unexpected shutdowns.
- Any connection instability should not cause game crashes.

Test Results from Verification and Validation Plan:

- **Test 12** involved running multiplayer sessions repeatedly to log crash occurrences.
- Testing was conducted through usability testing, where players ran multiple sessions of multiplayer games.

User Feedback from Usability Testing Report:

- No players reported game crashes during usability testing.
- Some testers experienced **connection instability** in the LAN version of the game.
- Connection issues are expected to be resolved with the implementation of the **Amazon EC2 server** for multiplayer.

Final Assessment: Pass

The game meets the **reliability requirement** as no crashes were reported during usability testing, and Test 12 confirmed stable multiplayer sessions. While there were reports of ****connection instability in the LAN version****, this is a separate issue that is expected to be resolved with the server-based multiplayer architecture.

4.3.5 NFR-5: Responsiveness

Requirement Description: The game shall respond to user inputs within 500 milliseconds in the worst case. Ensuring fast response times is critical to maintaining a smooth and frustration-free gameplay experience.

Evaluation Criteria:

- User input should result in a visible response within 500ms at least 99% of the time.

- No noticeable delays should occur in UI interactions, dice rolling, or menu navigation.
- Multiplayer input synchronization should not introduce noticeable input lag.

Test Results from Verification and Validation Plan:

- **Test 10** involved testing response times by performing varied actions in-game and noting any delays.
- No instances of response times exceeding 500ms were recorded during testing.

User Feedback from Usability Testing Report:

- No players reported **input delays or sluggish UI interactions**.
- Dice rolls, menu selections, and in-game interactions were consistently responsive.
- No complaints were made regarding **multiplayer latency affecting input responsiveness**.

Final Assessment: Pass

The game meets the **responsiveness requirement** as all recorded user interactions occurred within the expected 500ms threshold. Usability testing confirmed that no players encountered delays in UI navigation, dice rolling, or other gameplay actions, validating this requirement.

4.3.6 NFR-6: Modularity

Requirement Description: The game's codebase shall be modular, ensuring it is easily extendable and reusable, allowing for quick fixes to bugs and efficient implementation of new features.

Evaluation Criteria:

- Developers should be able to add new game modes and dice types without modifying unrelated existing code.
- The code should follow standard Object-Oriented Programming (OOP) principles and best practices for modularity.

- The use of **Godot-specific features** (such as signals and node groups) should facilitate modular development.

Test Results from Verification and Validation Plan:

- No applicable tests were included in the Verification and Validation Plan for modularity validation.

User Feedback from Usability Testing Report:

- No direct feedback from usability testing related to code modularity.

Justification for Final Assessment:

- The codebase was structured following **Object-Oriented Programming (OOP)** principles.
- **Godot-specific best practices**, including the use of **signals**, **node groups**, and **preloaded/global scripts**, were implemented to ensure modularity.
- The game architecture supports **adding new game modes and dice types** without requiring changes to unrelated code, meeting the fit criterion.

Final Assessment: Pass

The game meets the **modularity requirement** as its design follows **OOOP** principles and modular development best practices in Godot. While no explicit tests or usability feedback were available, the structure of the codebase enables **extendability and maintainability**, validating this requirement.

4.3.7 NFR-7: Efficiency

Requirement Description: The game shall be optimized to run on lower-end systems with minimal CPU and GPU resources while maintaining smooth gameplay performance.

Evaluation Criteria:

- The game should run smoothly on systems that meet the minimum system requirements.

- No major performance drops or stuttering should occur during game-play.
- The game should be optimized to minimize excessive CPU and GPU usage.

Test Results from Verification and Validation Plan:

- No applicable tests were included in the Verification and Validation Plan for efficiency validation.

User Feedback from Usability Testing Report:

- No players reported **performance issues** during usability testing.
- The game was tested on **various PC configurations**, and all systems were able to run the game smoothly.
- No testers experienced **frame rate drops, stuttering, or excessive resource usage**.

Final Assessment: Pass

The game meets the **efficiency requirement** as usability testing confirmed that it runs smoothly on all tested PC configurations without significant performance drops. While no explicit performance tests were included in the Verification and Validation Plan, real-world testing indicates that the game is well-optimized for lower-end systems.

4.3.8 NFR-8: Enjoyability

Requirement Description: The game shall be found enjoyable by at least 75% of users, ensuring that it appeals to a broad audience and provides an engaging experience.

Evaluation Criteria:

- At least 75% of users should rate the game as enjoyable based on post-game surveys or analytics.
- User feedback should indicate a positive overall reception of the game.
- Players should express interest in replaying the game.

Test Results from Verification and Validation Plan:

- No applicable tests were included in the Verification and Validation Plan for enjoyability validation.

User Feedback from Usability Testing Report:

- Players rated their likelihood of replaying the game on a **Likert scale (1-5)**, with an average score of **4.17**.
- Only **4% of players** indicated that they would either not play again or were neutral about replaying the game.
- The majority of responses were **positive**, confirming strong user engagement and enjoyment.

Final Assessment: Pass

The game meets the **enjoyability requirement**, as usability testing confirmed that the majority of players found the game enjoyable and expressed willingness to play again. The Likert scale average of 4.17 strongly supports that at least 75% of users enjoyed the game, validating this requirement.

4.3.9 NFR-9: Appearance

Requirement Description: The game shall maintain a consistent UI style and 3D visual style across all in-game views, ensuring visual continuity and a professional user experience.

Evaluation Criteria:

- UI elements and 3D assets should follow a predefined style guide.
- No major inconsistencies in visual elements should be present across different screens and game states.
- Players should not report jarring or conflicting visual themes.

Test Results from Verification and Validation Plan:

- No applicable tests were included in the Verification and Validation Plan for appearance validation.

User Feedback from Usability Testing Report:

- No players reported **issues with UI theming or inconsistencies**.
- Testers found the game's UI and 3D visual style **cohesive and visually appealing**.

Internal Testing and Implementation Measures:

- A **consistent UI theme file** was used throughout the game to ensure uniformity.
- A predefined **color palette and style guide** was applied to all UI elements.

Final Assessment: Pass

The game meets the **appearance requirement**, as usability testing confirmed no reported inconsistencies in UI theming or 3D assets. Internal testing ensured adherence to a predefined style guide, validating this requirement.

4.3.10 NFR-10: Portability (MacOS Support)

Requirement Description: The game shall be supported on MacOS devices to expand its potential audience and ensure accessibility for Mac users.

Evaluation Criteria:

- The game must successfully install and run on MacOS devices.
- The game must not have major performance issues or compatibility errors.
- Testing must be conducted on at least two different MacOS versions to validate cross-version compatibility.

Test Results from Verification and Validation Plan:

- No applicable tests were conducted in the Verification and Validation Plan, as MacOS support was out of scope for this phase of development.

User Feedback from Usability Testing Report:

- No usability testing was conducted on MacOS devices.
- All usability tests were performed on Windows PCs, meaning MacOS compatibility was not assessed.

Final Assessment: Fail (Stretch Goal)

MacOS support was identified as a **stretch goal** and was not included in the current development phase. As a result, no testing was conducted to verify MacOS compatibility, and the requirement remains unfulfilled at this stage. Future development efforts will need to include testing on MacOS devices before this requirement can be considered met.

4.4 Conclusion

The evaluation of the Non-Functional Requirements (NFRs) for **Dice Duels** demonstrates that the game successfully meets most of its defined criteria. The validation process involved a combination of tests outlined in the **Verification and Validation (V&V) Plan** and **Usability Testing Reports**, ensuring that the game meets expected performance, usability, reliability, and appearance standards.

Out of the ten evaluated NFRs:

- **Seven NFRs** (*Performance, Usability, Portability (Windows), Reliability, Responsiveness, Modularity, and Appearance*) received a **Pass**, indicating full compliance with their respective fit criteria.
- **Two NFRs** (*Efficiency and Enjoyability*) received a **Conditional Pass**, as they met requirements but have areas identified for further refinement in future updates.
- **One NFR** (*Portability (MacOS Support)*) received a **Fail**, as MacOS support was identified as a stretch goal and was not tested in this phase of development.

The results highlight that **Dice Duels** is a stable, performant, and engaging game that effectively delivers a seamless player experience. The game's **modular architecture and efficient UI design** ensure that it can be extended and improved upon in future iterations. The two conditionally passing requirements (*Efficiency and Enjoyability*) indicate that while the game is functional and enjoyable, there is room for optimization in music variety and further UI refinements.

The only failing NFR, MacOS support, was acknowledged as **out of scope for this phase** and will require targeted testing and development in a future iteration to meet the stated fit criterion.

Future Work: To further enhance the game’s quality, future testing should focus on:

- Further optimizing **efficiency** to ensure the game runs smoothly on low-end hardware.
- Expanding **usability enhancements**, such as improving UI clarity for scoring and variant tutorials.
- Conducting **MacOS compatibility testing** to fulfill the portability requirement.
- Refining **multiplayer connection stability** to improve overall reliability.

Overall, **Dice Duels** meets its core non-functional requirements and provides a strong foundation for future development, ensuring a high-quality and engaging experience for players.

5 Unit Testing

6 Changes Due to Testing

[This section should highlight how feedback from the users and from the supervisor (when one exists) shaped the final product. In particular the feedback from the Rev 0 demo to the supervisor (or to potential users) should be highlighted. —SS]

7 Automated Testing

8 Trace to Requirements

9 Trace to Modules

10 Code Coverage Metrics

References

Appendix — Reflection

The information in this section will be used to evaluate the team members on the graduate attribute of Reflection.

The purpose of reflection questions is to give you a chance to assess your own learning and that of your group as a whole, and to find ways to improve in the future. Reflection is an important part of the learning process. Reflection is also an essential component of a successful software development process.

Reflections are most interesting and useful when they're honest, even if the stories they tell are imperfect. You will be marked based on your depth of thought and analysis, and not based on the content of the reflections themselves. Thus, for full marks we encourage you to answer openly and honestly and to avoid simply writing "what you think the evaluator wants to hear."

Please answer the following questions. Some questions can be answered on the team level, but where appropriate, each team member should write their own response:

1. What went well while writing this deliverable?
 - Since we already had the VnV Plan in a completed state, we were familiar with both the product and the VnV process we were looking to undertake. (John P.)
2. What pain points did you experience during this deliverable, and how did you resolve them?
 - This deliverable came near the end of the development process, when the game was mostly completed save some final features and bugs, meaning there was some lack in motivation due to the work being more maintenance based. There was additionally exams and other events during this time. To help resolve this, the extension to the due date was of help and meetings where we discussed the final steps and end goals were had to help us hunker down and get the work over with. (John P.)
3. Which parts of this document stemmed from speaking to your client(s) or a proxy (e.g. your peers)? Which ones were not, and why?

- The most significant element of this document that stemmed from speaking to the stakeholders of the project came through usability testing and playtesting feedback. As of 2025-03-09, 27 of 137 feature and bug issues on github stem from playtesting feedback. This feedback comes from external testing as we had internal testing and playtesting as well which generated issues. These issues addressed different elements of functional and nonfunctional requirements but especially led to the use of the section addressing changes due to testing. (John P.)
4. In what ways was the Verification and Validation (VnV) Plan different from the activities that were actually conducted for VnV? If there were differences, what changes required the modification in the plan? Why did these changes occur? Would you be able to anticipate these changes in future projects? If there weren't any differences, how was your team able to clearly predict a feasible amount of effort and the right tasks needed to build the evidence that demonstrates the required quality? (It is expected that most teams will have had to deviate from their original VnV Plan.)
- ...