Web Implementation of 3-way Chess

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Abstract

This paper presents the design and implementation of a web-based platform for three-player chess, a non-standard variant developed by Dario Varga that until now has only existed in physical form. The work addresses several human–computer interaction challenges: intuitive visualization of a hexagonal chessboard, synchronization of three players in real time, and support for learning unfamiliar rules. The platform was developed using Node.js, React, Mantine, Socket.IO, and MongoDB, providing user account management, both single-device and online multiplayer modes, and access to game history. A key contribution lies in creating a user-friendly and responsive interface that lowers the entry barrier for new players while ensuring robust performance in real-time gameplay. Evaluation confirmed that the application meets functional requirements and offers minimal latency for online play, with results highlighting the impact of server proximity on player experience. The project demonstrates how thoughtful interaction design and modern web technologies can support the digital transformation of analog games, broadening accessibility and engagement with alternative chess variants. The system is available at: https://chess3.musiclab.si/.

Keywords

human-computer interaction, chess, online games,

1. Introduction

Chess is one of the most enduringly popular strategy games worldwide, with millions of players engaging through physical boards and digital platforms. Over the past two decades, online platforms such as Chess.com[1] and Lichess.org[2] have made chess more accessible than ever, blending competitive play with learning tools and community features. Alongside standard chess, a wide variety of variants have been developed to expand gameplay and introduce new challenges. Such variants[3] include multiple types of games on a similar 8×8 two-color chessboard, while others also introduce new chessboard designs. Among the latter is also *Varga's 3-way chess*, an alternative version designed by Slovenian actor Dario Varga in the late 20th century. Played on a hexagonal board with 96 cells, it introduces a third color, a third set of pieces, and new movement rules, offering a fundamentally different dynamic of alliances, competition, and strategy.

Despite its unique appeal, Varga's 3-way chess has remained largely confined to physical boards. More about the Varga's version of the chess is presented in [1]. This limitation restricts its reach: learning the rules is difficult without direct guidance, and physical play requires access to a specially designed board and pieces. As a result, the game has never achieved broad popularity. A digital implementation could overcome these barriers by enabling easier rule learning, remote multiplayer play, and global accessibility.

Developing such a platform, however, introduces significant Human-Computer Interaction (HCI) challenges. First, the non-standard chess logic and rule set must be represented in a way that players can easily understand, even if they are unfamiliar with the variant. Second, the visualization of a non-traditional hexagonal chessboard demands careful design to ensure clarity and usability across devices.

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[1] https://www.chess.com

[2] https://lichess.org

[3] https://en.wikipedia.org/wiki/List_of_chess_variants

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Third, the platform must synchronize three players in real time, managing fairness and responsiveness while preserving an engaging user experience.

In this paper, we present the design and implementation of a web-based platform for three-player chess that addresses these challenges. The system was developed using modern web technologies and was evaluated with respect to usability, responsiveness, and functional completeness. Beyond its technical contributions, the platform demonstrates how digital interaction design can preserve and popularize niche analog games, broadening access to novel cultural and recreational practices.

2. Related Work

Research on digital chess platforms spans education, usability, and multiplayer interaction design. Early work by Picussa et al. [2] explored online educational environments for chess, showing how digital platforms can support teaching and learning by providing real-time feedback and interactive explanations. Similarly, Guid et al. [3] demonstrated the potential of intelligent tutoring systems in chess endgames, focusing on adaptive explanations and player progress tracking. These contributions highlight the importance of user-centered approaches when digitizing traditional board games.

Several studies have investigated technical and interaction challenges of web-based chess implementations. Palomäki [4] examined cross-device human-versus-human play in browser-based chess, emphasizing synchronization and latency issues. Hostettler and Boner [5] focused on digitizing chess scorecards, underlining the role of digital tools in preserving and extending traditional practices. More recently, Vasiljević [6] proposed adapting AlphaZero for three-player hexagonal chess, addressing the computational challenges posed by non-standard rules and board geometries.

Mainstream online chess platforms provide important benchmarks for design and usability. Chess.com is the largest commercial chess service, with over 100 million registered users[4] and was the most downloaded iOS game in 28 countries in 2023[5]. Its infrastructure leverages modern distributed technologies[6,7]. In contrast, Lichess.org is fully open-source[8], free of ads, and community-driven[9], integrating Stockfish[10] through WebAssembly[11]. These platforms exemplify best practices in real-time communication, user experience, and scalability, offering design principles relevant to emerging variants.

Three-player chess has been studied less extensively. Historical overviews document numerous hexagonal and triangular board variants[12], yet few digital implementations exist. One notable example is a community-driven platform of a different game variant that allows browser-based play with friends[13]. However, such implementations typically lack matchmaking, persistent accounts, or large-scale adoption, illustrating the gap between experimental variants and mainstream digital platforms.

3. Background

Varga's 3-way chess is a non-standard variant of chess. Unlike traditional chess, which is played between two players on an 8×8 square grid, this variant is played by three participants on a hexagonal board consisting of 96 fields and is illustrated in fig. 1. Each player controls a standard set of chess pieces—pawns, rooks, knights, bishops, a queen, and a king—positioned along one of the three sides of the hexagon. The rules extend classical chess while introducing new dynamics of competition and alliance.

[4] https://en.wikipedia.org/wiki/Chess.com
[5] https://www.chess.com/news/view/chesscom-number-one-in-ios-app-store
[6] https://www.redpanda.com/case-study/chess-com
[7] https://himalayas.app/companies/chess-com/tech-stack
[8] https://github.com/lichess-org/lila
[9] https://lichess.org/about
[10] https://stockfishchess.org
[11] https://webassembly.org
[12] https://en.wikipedia.org/wiki/Three-player_chess
[13] https://www.reddit.com/r/chessvariants/comments/116dnuu/i_made_a_website_to_play_three_player_chess_with/

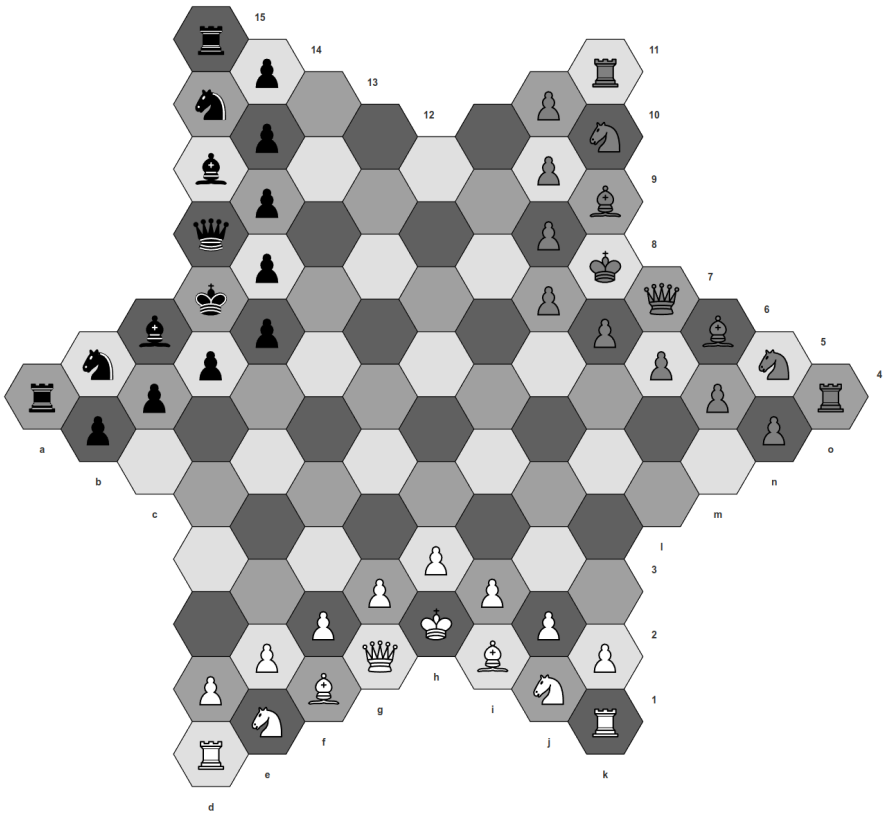

Figure 1: Varga's 3-way chess board has 96 fields divided between three colors, and 16 chess pieces per player also in three colors.

3.1. Movement Rules

Most pieces retain their standard movement patterns, but these are adapted to the geometry of the hexagonal board:

- **Pawns** move one step forward and capture diagonally forward, with promotion possible upon reaching the farthest rank relative to their starting position.
- **Rooks** move along straight lines radiating outward from the hexagon.
- **Bishops** move diagonally across the hexagonal grid, which allows them to cover new movement paths not present in standard chess.
- **Knights** retain their characteristic "L"-shaped movement, adapted to the hexagonal geometry.
- **Queens** combine the movement of rooks and bishops.
- **Kings** move one step in any direction and may castle under conditions analogous to standard chess.

3.2. Turn Order and Gameplay

Turns proceed sequentially in a clockwise order around the board, giving each of the three players equal opportunity to move. The game begins with white, followed by the next player in rotation. This structure introduces strategic complexities, as each move must account for two opponents rather than one.

3.3. Check, Checkmate, and Elimination

A king placed under threat is considered to be in check, as in standard chess. If a player is checkmated, their pieces are removed from the board, effectively clearing the space for the remaining players. The game continues until one player successfully checkmates the final opponent, thereby claiming victory.

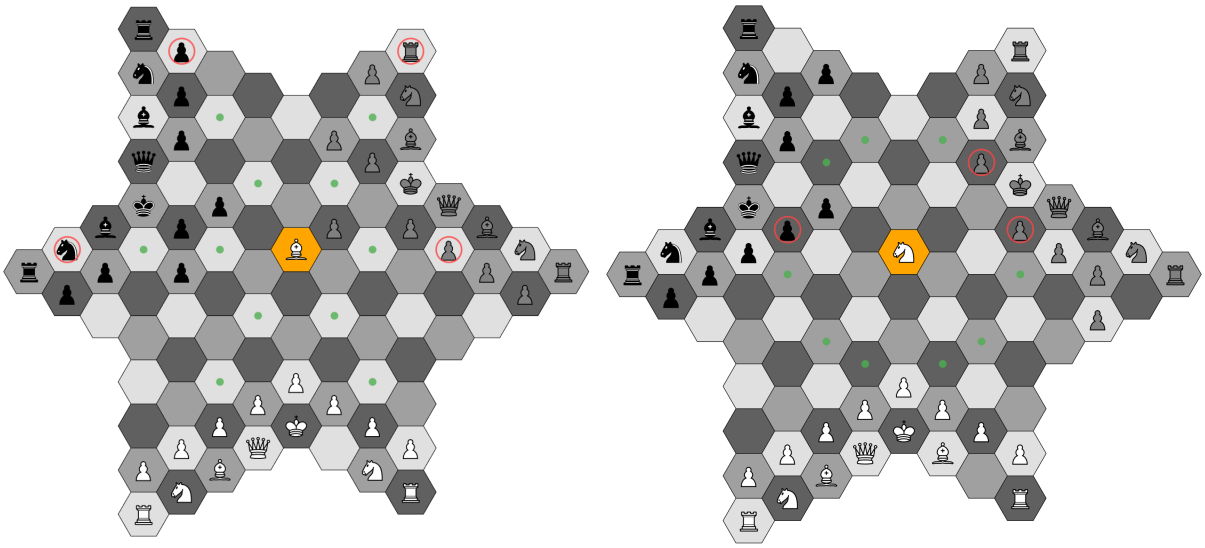

Figure 2: Valid moves for white bishop the left image and for white knight in the right image.

3.4. Strategic Implications

The introduction of a third player creates possibilities for temporary alliances, betrayals, and shifting balances of power. Unlike standard chess, where play is strictly adversarial, three-player chess often requires situational cooperation to prevent one player from gaining an overwhelming advantage. This dynamic makes the variant highly unpredictable and strategically distinct from its two-player counterpart.

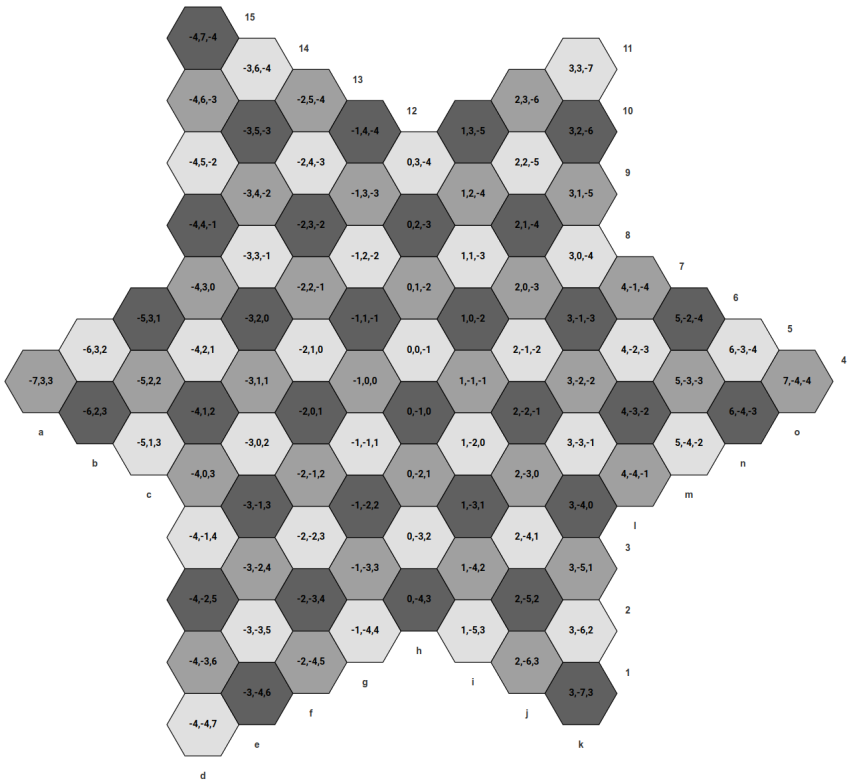

Figure 3: Coordinate system for hexagonal chessboard.

3.5. Coordinate System

To represent the hexagonal board computationally, a coordinate system was defined that assigns a unique label to each of the 96 fields as shown in fig. 3. Unlike the square 8×8 grid of traditional chess, the hexagonal board requires a two-dimensional axial coordinate system, where each field is described by a pair of indices corresponding to its row and diagonal alignment. This approach ensures that piece movement can be calculated consistently, regardless of orientation. For human readability, the system was adapted into an alphanumeric notation similar to algebraic chess notation: files are labeled with letters (A–L) and ranks with numbers (1–16), omitting unused coordinates. This design allows players to communicate moves unambiguously while supporting efficient internal data structures for move validation.

3.6. HexFEN Notation

In order to store and exchange game states, we developed an extension of the standard Forsyth–Edwards Notation (FEN), which is widely used in digital implementations of classical chess. The adapted format, referred to as *HexFEN*, encodes the positions of all three sets of pieces on the 96-field board as shown in fig. 4. Each rank of the hexagonal board is represented as a string, with numbers indicating consecutive empty fields and letters denoting pieces, differentiated by color. The notation also encodes additional information such as the player on turn, castling rights, and en passant possibilities. For example, the initial setup of Varga's 3way chess can be expressed as a single HexFEN string, enabling straightforward storage, retrieval, and reconstruction of board states. This notation proved essential for implementing features such as game history replay, server–client communication, and debugging of rule enforcement.

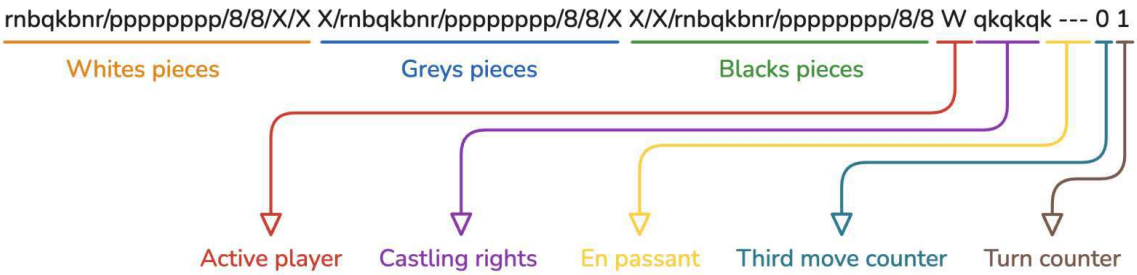

Figure 4: The structure of the HexFEN format

4. Methodology

The development of the platform followed a user-centered design process, complemented by iterative technical prototyping. Our primary aim was to translate the physical version of Varga's three-player chess into a digital format that would be both accessible and intuitive for new players. The methodology consisted of three phases: requirements gathering, system design and implementation, and evaluation.

4.1. Requirements Gathering

We began by analyzing the unique characteristics of three-player chess, including its hexagonal board layout, expanded movement rules, and three-way turn structure. This analysis revealed several HCI challenges: (1) learning support for unfamiliar rules, (2) visualization of a non-standard board, and (3) synchronization of three players in real-time gameplay. To address these, we reviewed established online chess platforms Chess.com and Lichess.org, extracting best practices in usability, responsiveness, and real-time interaction. Additionally, we studied community-driven implementations of three-player chess, which helped identify common limitations such as a lack of matchmaking, incomplete rule support, and low accessibility.

4.2. System Design and Implementation

Based on the identified requirements, we designed the platform as a web application accessible from any modern browser. The system architecture consists of two main components: (1) a backend server handling authentication, game logic, synchronization and database for; and storing accounts, game states, and histories (2) a front-end interface providing visualization and user interaction.

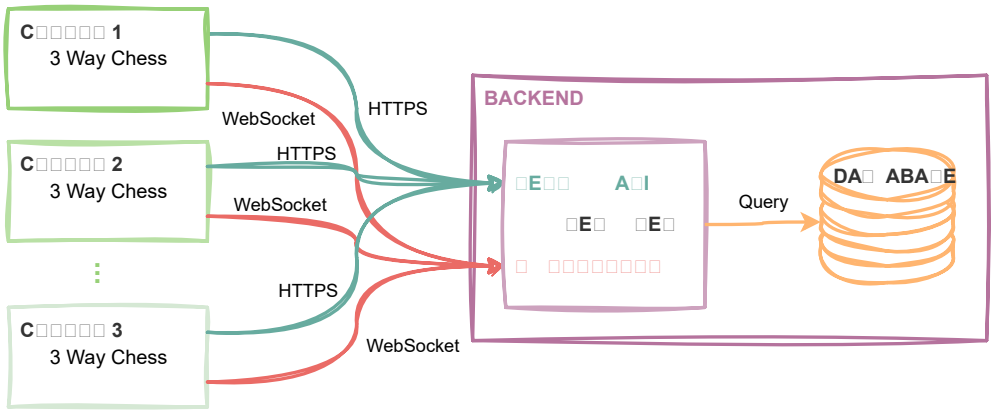

Figure 5: Diagram of the system architecture.

The back-end was implemented using Node.js[14] and Express.js[15] to provide a scalable environment for managing requests and routing. Real-time gameplay was supported by Socket.IO[16], ensuring low-latency synchronization of moves between players. Game state validation was performed using a WebAssembly[17] module adapted from existing research on three-player chess engines, enabling efficient rule enforcement in the browser.

The front-end was built using React[18], selected for its modular, component-based architecture, and extended with Mantine[19] to accelerate development of responsive, accessible UI components. To support reliability and consistency across both the client and server, we adopted TypeScript[20] for static type checking. The unconventional chessboard visualization was implemented as a dynamic SVG-based grid, capable of rotating perspectives for different players to reduce cognitive load.

For data storage, we used MongoDB[21] as a NoSQL database, providing flexibility for managing heterogeneous data structures such as user profiles and move sequences. Mongoose[22] was integrated to enforce schema validation, ensuring the integrity of stored records.

4.3. Evaluation

To validate the platform, we conducted two types of evaluation. First, a functional evaluation tested compliance with the identified requirements, confirming that features such as account management, online multiplayer, and game history replay worked as intended. Second, a performance evaluation measured latency in real-time synchronization, comparing server locations in Europe and the United States. These tests highlighted the importance of server proximity, with local servers reducing move

[14] https://nodejs.org/en/about
[15] https://expressjs.com/
[16] https://socket.io/
[17] https://webassembly.org/
[18] https://react.dev/
[19] https://mantine.dev/
[20] https://www.typescriptlang.org/
[21] https://www.mongodb.com/
[22] https://mongoosejs.com/

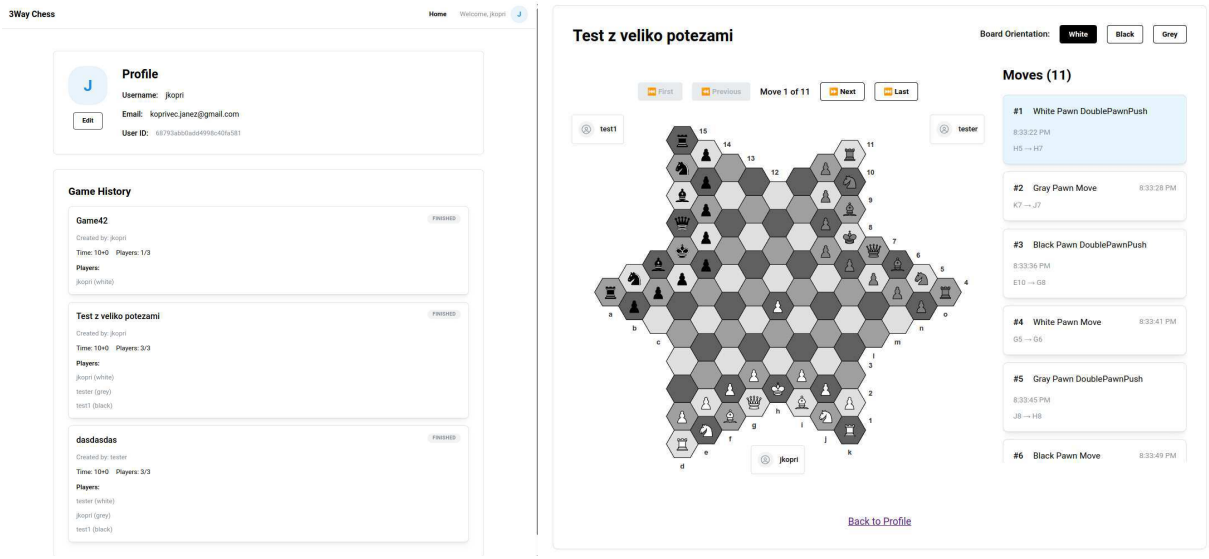

Figure 6: UI implementation of user profile (left) and game review screen (right).

transmission delay by more than an order of magnitude. While primarily technical, these evaluations provide insights into the relationship between system responsiveness and perceived fairness in multiplayer environments, an essential HCI consideration.

5. Results

The platform was evaluated with respect to functionality, usability, and technical performance. The results demonstrate that the system successfully enables three-player chess to be played online while addressing the challenges of rule enforcement, board visualization, and real-time synchronization. The deployment of the system is available at: https://chess3.musiclab.si/.

5.1. Functional Results

All core features were implemented and verified through extensive playtesting. Players were able to create and manage accounts, initiate both local (same-device) and online multiplayer matches, and access their game history. The platform correctly enforced the rules of Varga's 3-way chess, including piece movements on the hexagonal board and the sequential turn system for three participants. The replay feature provided a complete record of past matches, supporting both learning and post-game analysis.

5.2. Usability Outcomes

From an interaction design perspective, the dynamic SVG-based chessboard proved effective in visualizing the unconventional geometry. Color-coded move indicators, turn notifications, and perspective rotation helped reduce player confusion during gameplay. Informal usability testing with novice players indicated that most users were able to learn the rules of the variant within a few rounds, suggesting that the interface supports learnability despite the unfamiliar mechanics. Participants also reported that the design of the interface was clear and consistent across devices, which can be attributed to the responsive layout and accessible component library provided by Mantine. The UI implementation of user profile view and game review

5.3. Performance Evaluation

System responsiveness was measured by recording round-trip times for move transmission under different server configurations. When hosted on a European server, latency remained consistently below 30 ms, which was not perceptible to players. However, when connecting to a U.S.-based server from Europe, latency increased by up to ~1 s, occasionally disrupting the flow of play. These results, also shown in table 1, confirm that server proximity has a direct impact on user experience in real-time multiplayer games. The integration of Socket.IO successfully minimized delays under optimal network conditions, but global scalability will require distributed server deployment.

Table 1
Performance evaluation of online play using servers at different locations.

Server Location	Average Latency (ms)	Maximum Latency (ms)	Player Experience
Europe (Ljubljana)	21.32	29.5	Smooth, no disruptions
United States (Virginia)	736.76	2116.0	Noticeable delays, disrupted flow

Overall, the evaluation confirmed that the platform meets the functional and interaction requirements identified during the design phase. It not only enables accessible play of a niche chess variant but also demonstrates how careful integration of visualization, interaction design, and network performance considerations can enhance the usability of digital board games.

6. Discussion

The development and evaluation of the platform demonstrate that translating niche board games into digital environments requires more than a direct technical implementation. It demands thoughtful consideration of HCI principles to ensure that new players can learn the rules, navigate unfamiliar visualizations, and maintain engagement in real-time multiplayer contexts.

6.1. Balancing Familiarity and Novelty

One of the central challenges was the visualization of the hexagonal chessboard. Traditional chess interfaces rely on a highly standardized square grid that players recognize immediately. In contrast, the three-player variant introduces new geometries and movement patterns that are not part of players' prior experience. By incorporating perspective rotation, turn indicators, and color-coded feedback, the platform reduced cognitive load and helped players adapt more quickly. This illustrates the broader HCI principle that unfamiliar mechanics should be introduced through scaffolding that bridges the gap between old and new interaction paradigms.

6.2. Responsiveness and Perceived Fairness

Performance evaluation highlighted the close relationship between network latency and user experience in multiplayer environments. Even small delays in move synchronization can undermine the perception of fairness, especially in a strategic game where timing and precision are crucial. While Socket.IO effectively minimized delays on local servers, cross-continental play revealed the limits of centralized hosting. This finding aligns with broader HCI research showing that technical performance is deeply entangled with user trust and engagement in online systems. Future work could explore distributed or peer-to-peer architectures to further reduce latency and improve global accessibility.

6.3. Usability and Learnability

Although the rules of three-player chess are inherently more complex than those of standard chess, informal usability testing suggested that most players were able to understand the basics within a few

rounds. This indicates that the interface design supported learnability by making rules visible through interactive feedback, rather than relying solely on textual explanations. Integrating tutorials, tooltips, or adaptive hints could further lower the entry barrier and make the game more approachable to a wider audience.

6.4. Broader Implications

Beyond the specific case of three-player chess, this work contributes to ongoing discussions in HCI about the digital transformation of cultural practices. Many traditional games and variants remain locked in physical formats due to their unconventional rules or non-standard equipment. By showing how modern web technologies can be combined with user-centered design, this project demonstrates a pathway for preserving and revitalizing such practices in digital form. The insights gained—particularly regarding visualization of non-standard boards, synchronization of more than two players, and scaffolding for rule learning—may be applied to other games and domains where digital adoption has been limited.

Overall, the study highlights the importance of aligning technical design choices with usability principles. A focus on responsiveness, clarity, and learnability allowed us to create not only a functioning multiplayer application but also an interaction environment that invites players to explore, understand, and enjoy a novel chess variant.

7. Conclusion

This paper presented the design and implementation of a web-based platform for Varga's 3-way chess, a niche board game variant that has remained largely inaccessible in digital form. By combining modern web technologies with a user-centered design approach, we demonstrated how challenges of non-standard board visualization, rule enforcement, and real-time synchronization can be addressed in a way that supports usability and engagement.

The results showed that the platform successfully enables both local and online multiplayer play, with functional features such as account management, game history replay, and responsive visualization of the hexagonal chessboard. Informal usability testing indicated that players were able to learn the unfamiliar rules within a few sessions, suggesting that interaction design elements such as color coding, turn indicators, and perspective rotation effectively reduce cognitive load. Performance evaluation further highlighted the importance of server proximity for maintaining fairness and flow in multiplayer interaction.

Beyond the specific case of three-player chess, this work illustrates how thoughtful application of web technologies can broaden access to alternative game variants and preserve cultural practices through digital transformation. Future work will expand on this foundation by integrating structured usability studies, distributed server architectures for global play, and interactive tutorials that further support learning. More broadly, the study underscores the potential of HCI-driven design to make experimental and unconventional games more accessible, inclusive, and engaging in digital environments.

Acknowledgments

We would like to express our gratitude to Dario Varga, the creator of three-player chess, for his originality and contribution in designing this unique variant of the game. His innovative approach to extending the classical rules of chess to a three-player format provided the inspiration and foundation for this work. Without his creativity and dedication, the development of a digital platform for three-player chess would not have been possible.

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