

Game collections management system: Usability, Prototype and Evaluation

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1. Product prototype

1.1 Prototype Introduction

The prototype of the Game Management System in this project is the web application adopting the framework **Springboot + Vue.js**, following the principle of separation of front-end and back-end development. In Submission one, we initially chose Angular.js as the front-end framework, but in the subsequent development we chose Vue.js instead which is lighter and more usable. In addition, compared with the complete product, we have only implemented a prototype application with certain functions. Nevertheless, this prototype framework we designed has a high usability for continued development, and it is easy for programmers to develop it in future work. The code for this prototype is provided on GitHub.

(<https://github.com/mansonliwh/GameManagementSystem>)

The architecture design of the complete application is generally consistent with the description of Submission one. In addition, we will analyze the prototype application we created. The following sections will cover the functionality and UI design of the prototype implementation, the database design, the software architecture and other technical methodology.

1.2 Functionality and UI design

1.2.1 Functionality

In this prototype application we have realized most of the main functions, including forums, game categories and favorites collection etc. In addition, we have designed a database of three main modules, including games, forum articles and users. The specific functions will be displayed in the form of the following table.

Module	Function
User	Login
	Logout
	Register

Game	Divided by catetories
	Divided by labels
	Display all the games list
Collection	Display the games list of the users' different favorites
Forum	Display all the posts(articles) list
Posts(articles)	Divided by catetories
	Divided by labels
	Write/edit a new post
	View the detail
Comments (on posts)	Write/edit a new comment
	Reply other comment
System Log	View system log in database

Table 1: Functions developed in each module

1.2.2 UI Designed

The design of the UI will be displayed in the form of pictures according to different functions.

Home page

The homepage will be the homepage of the game forum, where players can browse posts by clicking on the article title. Both the title and the label on the right can be clicked. After clicking, the page can be directed to the article(posts) list under the corresponding category.

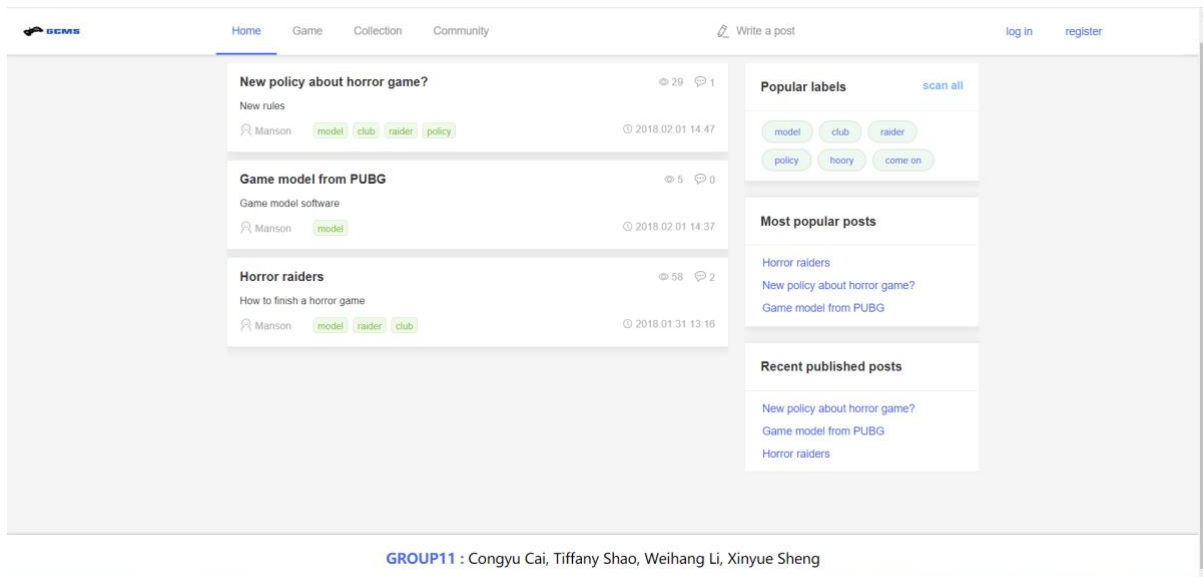


Figure 1.1: Home page

Login/Logout/Register page

Most functions of the webpage can be used only after logging in.

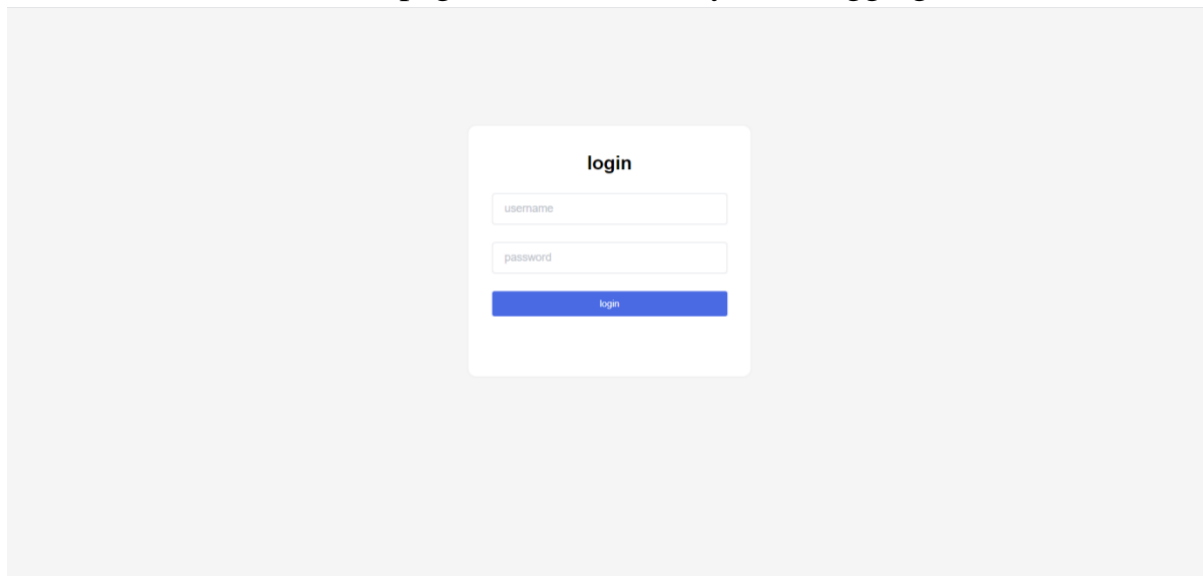
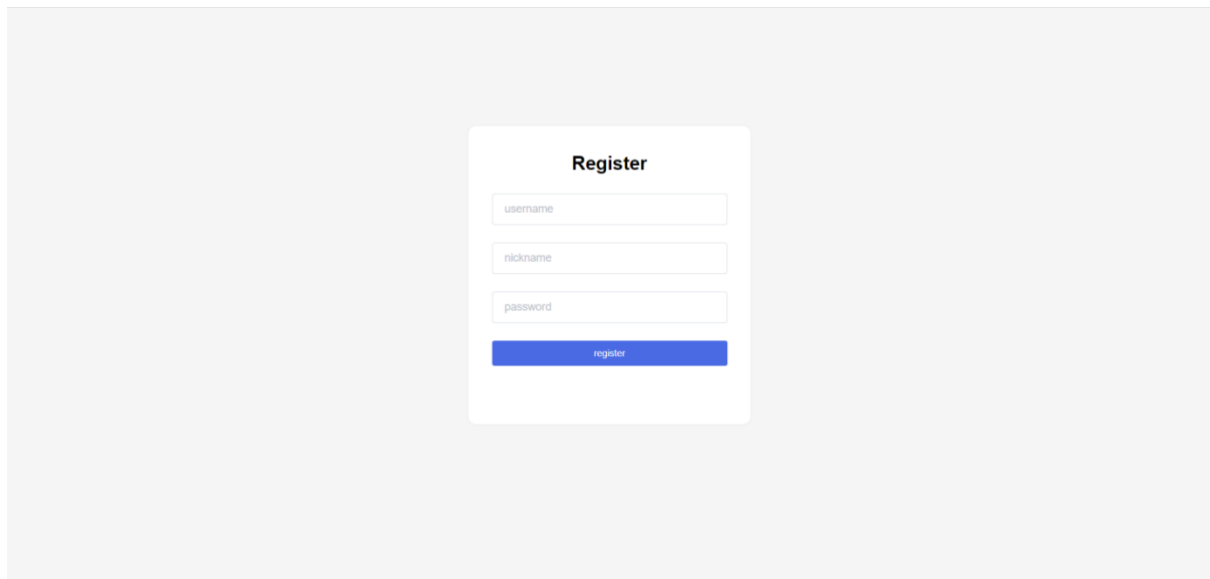


Figure 1.2: login page

A registration form titled "Register" is centered on a light gray background. The form is a white rectangle with a thin border. It contains three input fields: "username", "nickname", and "password", each with a small placeholder text. Below the input fields is a blue button with the text "register" in white. The form is simple and clean, with no additional styling or icons.

Register

username

nickname

password

register

Figure 1.3: register page

Game category/label page

Games are classified by different categories and tags(labels). Clicking on different categories and tags will enter the divided game list page. Each piece of game information displays its price, rating, author and year of release.

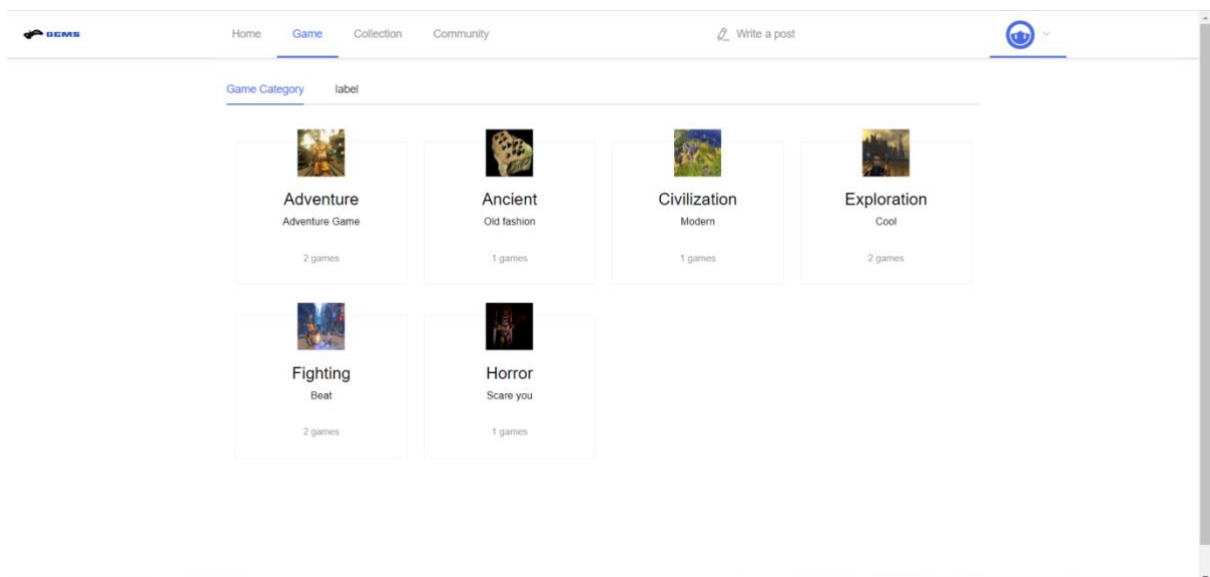


Figure 1.4: game category page

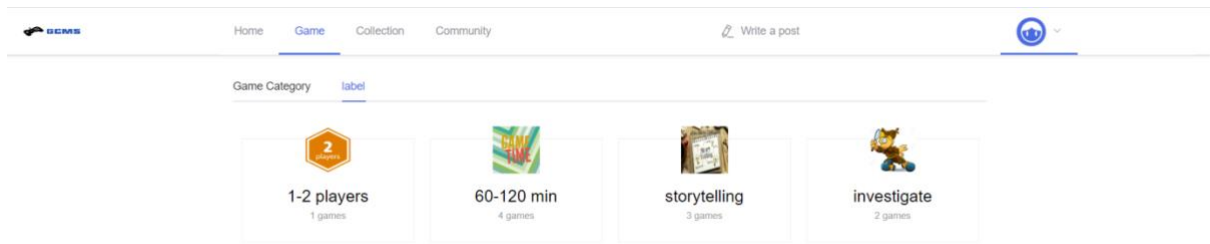


Figure 1.5: game label page

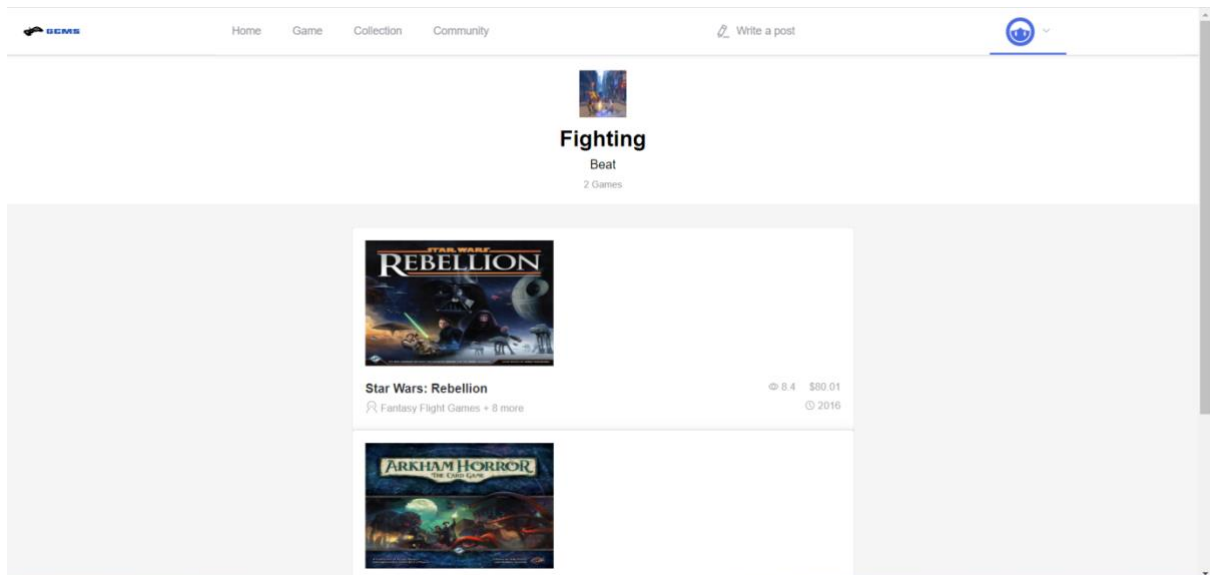


Figure 1.6: divided game list page

Collection page

Display games in the user's favorites, and by default, display all games the user has favorited.

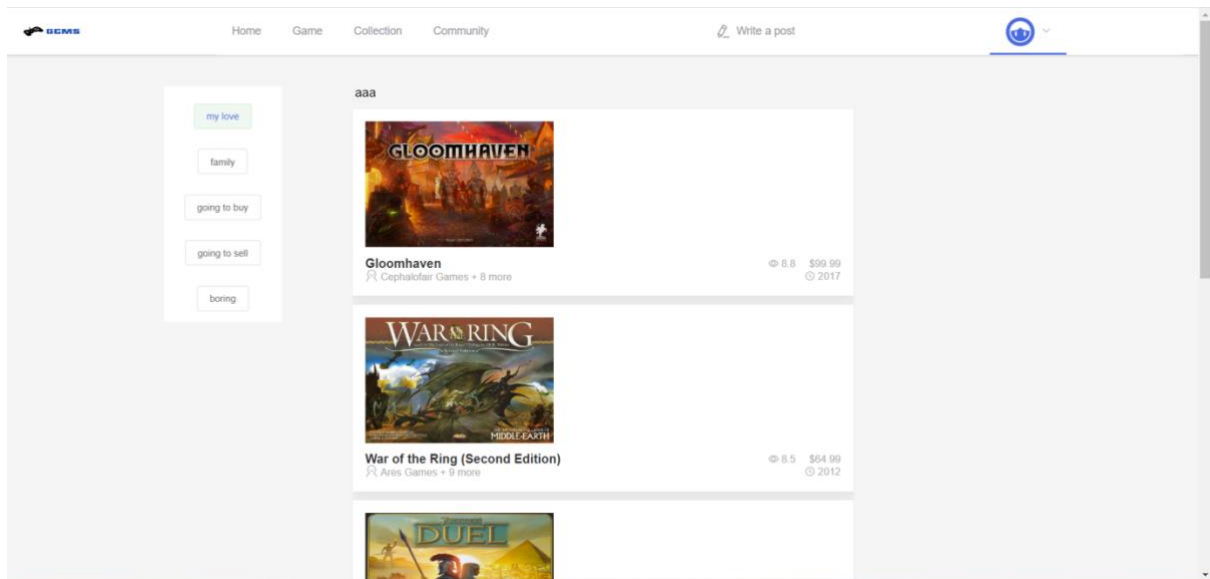


Figure 1.7: collection page

Post (Article) category/label page

Articles are classified by different categories and tags(labels). Clicking on different categories and tags will enter the divided articles list page. Each piece of article information displays its viewer counts, comment counts, author and release date.

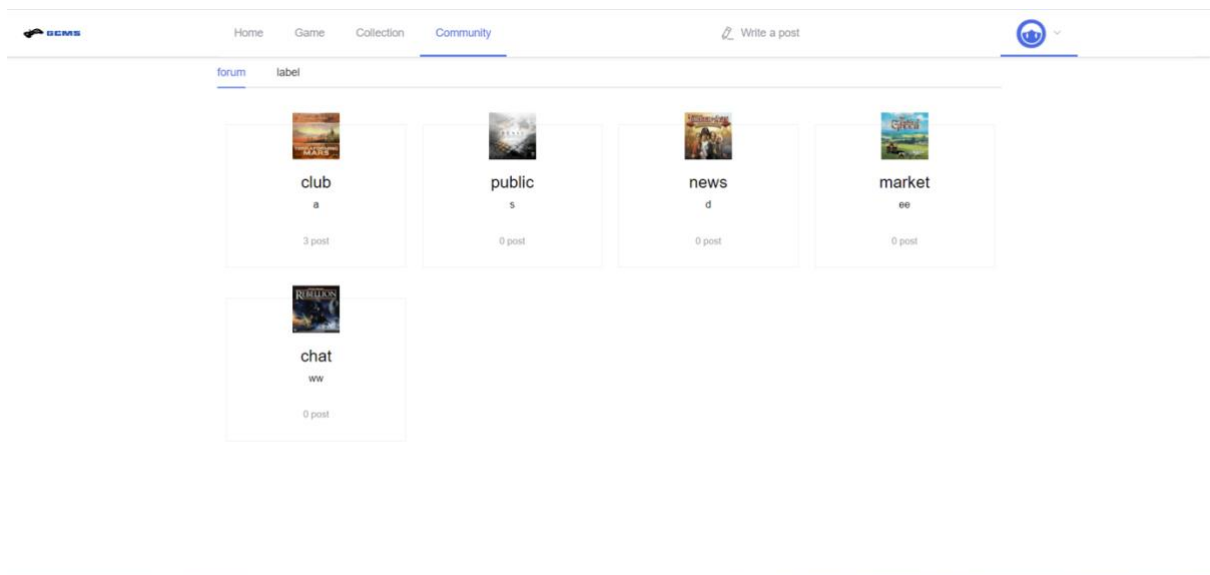


Figure 1.8: article(post) category page

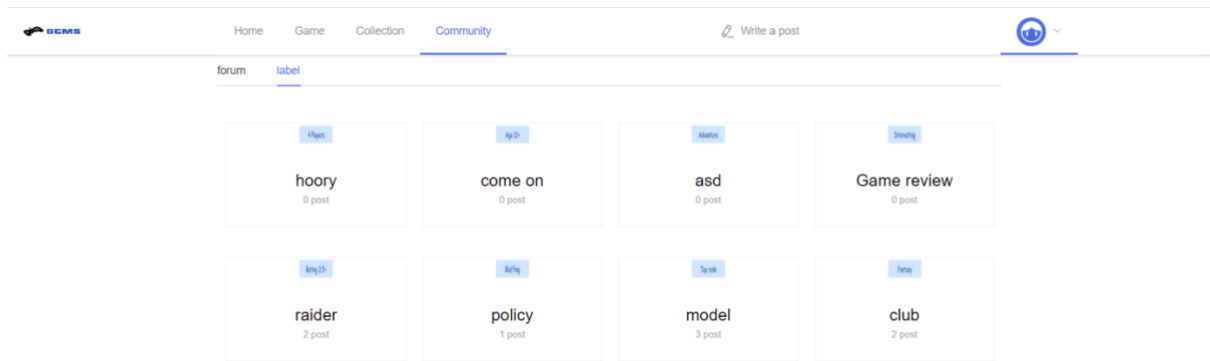


Figure 1.9: article(post) label page

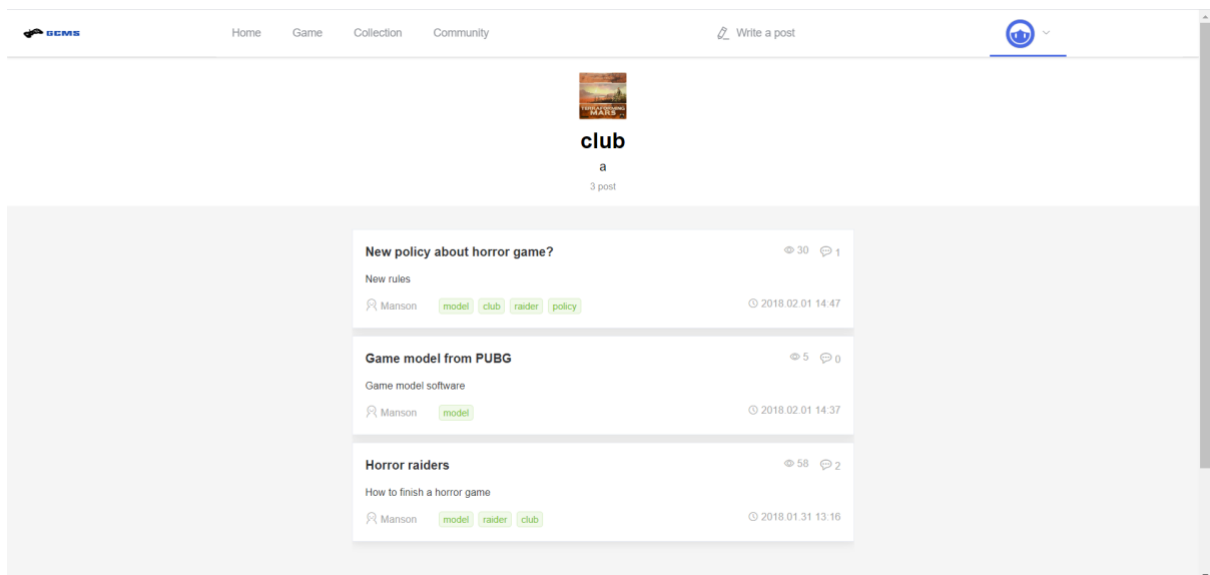


Figure 1.10: divided article(post) list page

Post (Article) View page

This page can observe the detailed content of the article. In addition, users can comment and reply to comments below.

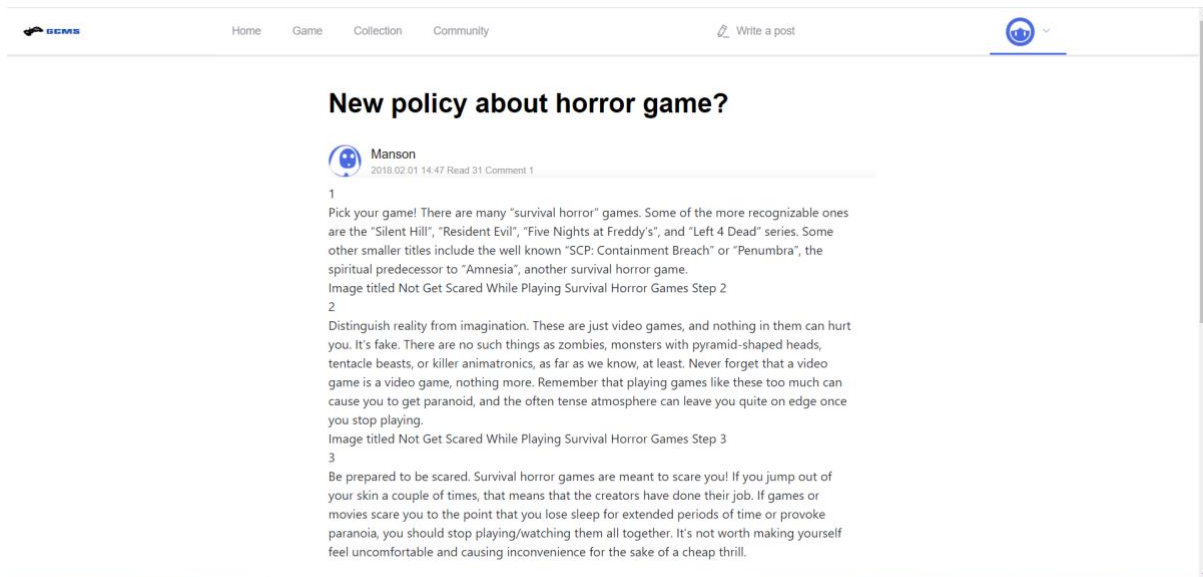


Figure 1.11: article(post) view page

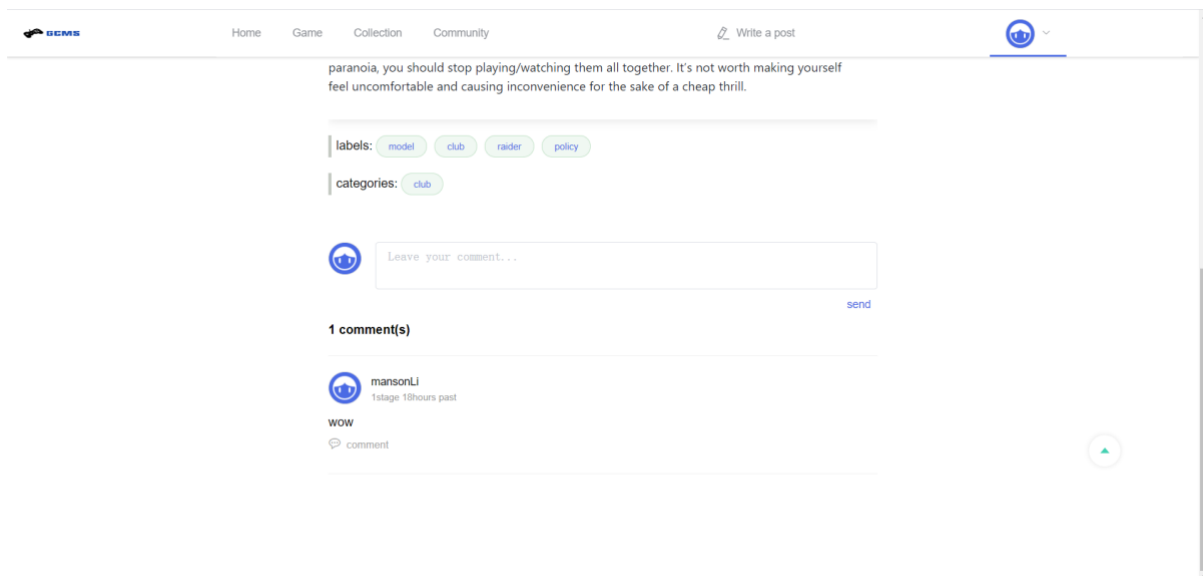


Figure 1.12: article(post) view page with comment

Post(Article) write/edit page

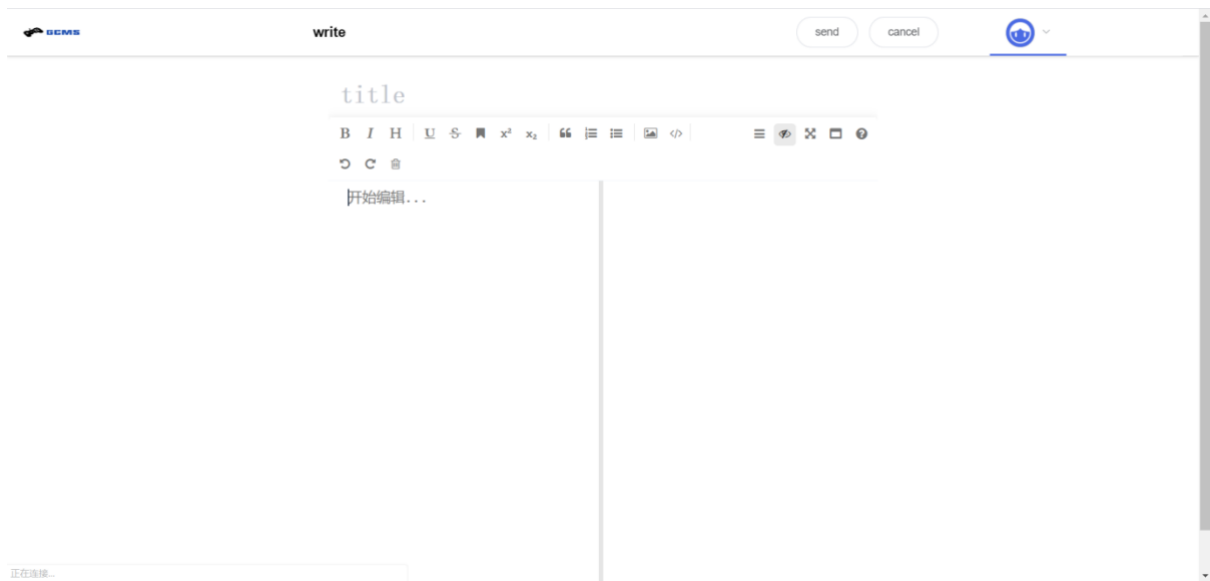


Figure 1.13: article(post) write/edit page

1.3 Database design

The database mainly includes three core modules, users, games and articles. There are a total of 14 data tables, including one used to record the system log. On the technical level, we used the architecture of **Mysql 8.0.15 + Redis 3.2.1**. The main function of Redis is to store the cache and reduce the pressure on the persistent database. If our demand is when multiple users, high concurrent insert data and a large number of queries will make the database very stressful. At this time, you need to use redis as the cache, and put the query logic into the cache to execute. The following picture will show the ER diagram and data dictionary for this database.

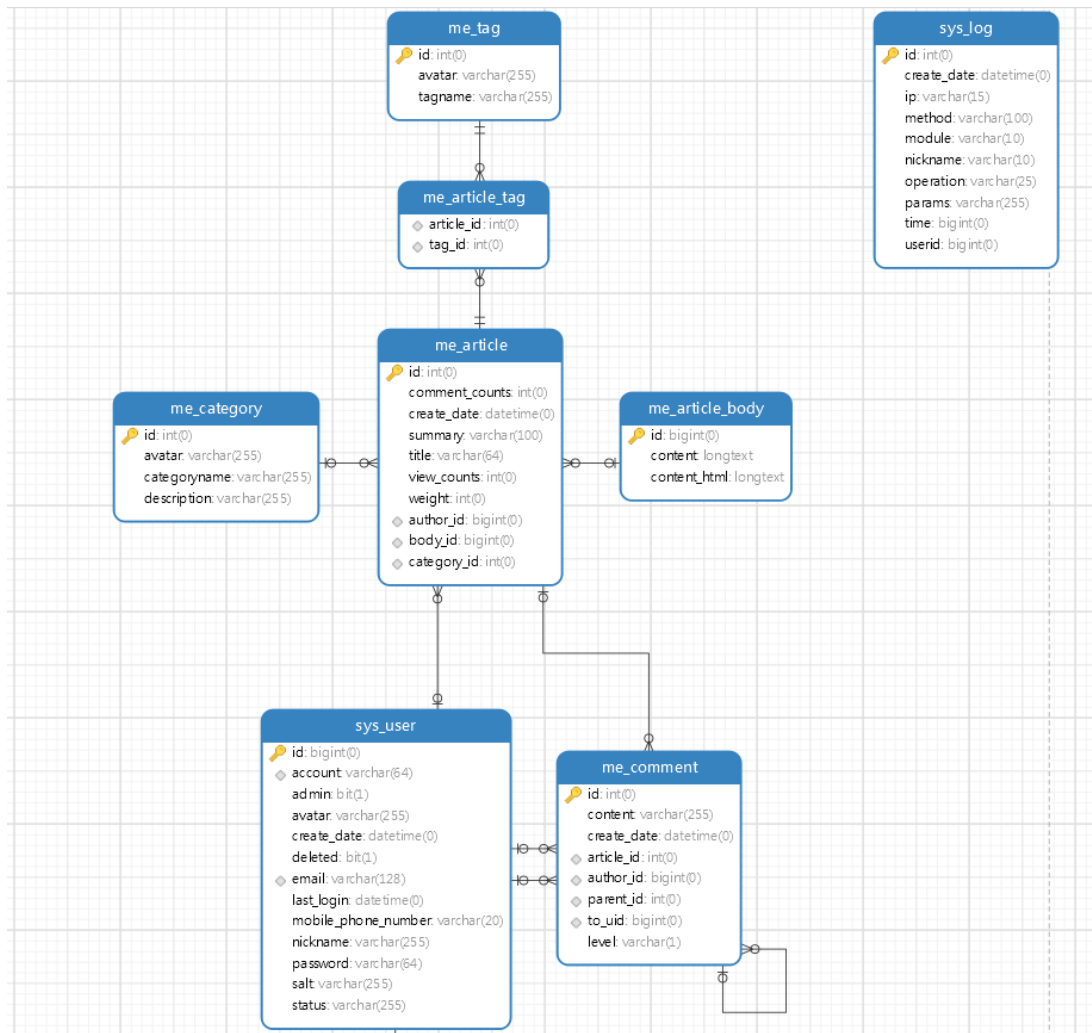


Figure 1.14: ER diagram and data dictionary 1

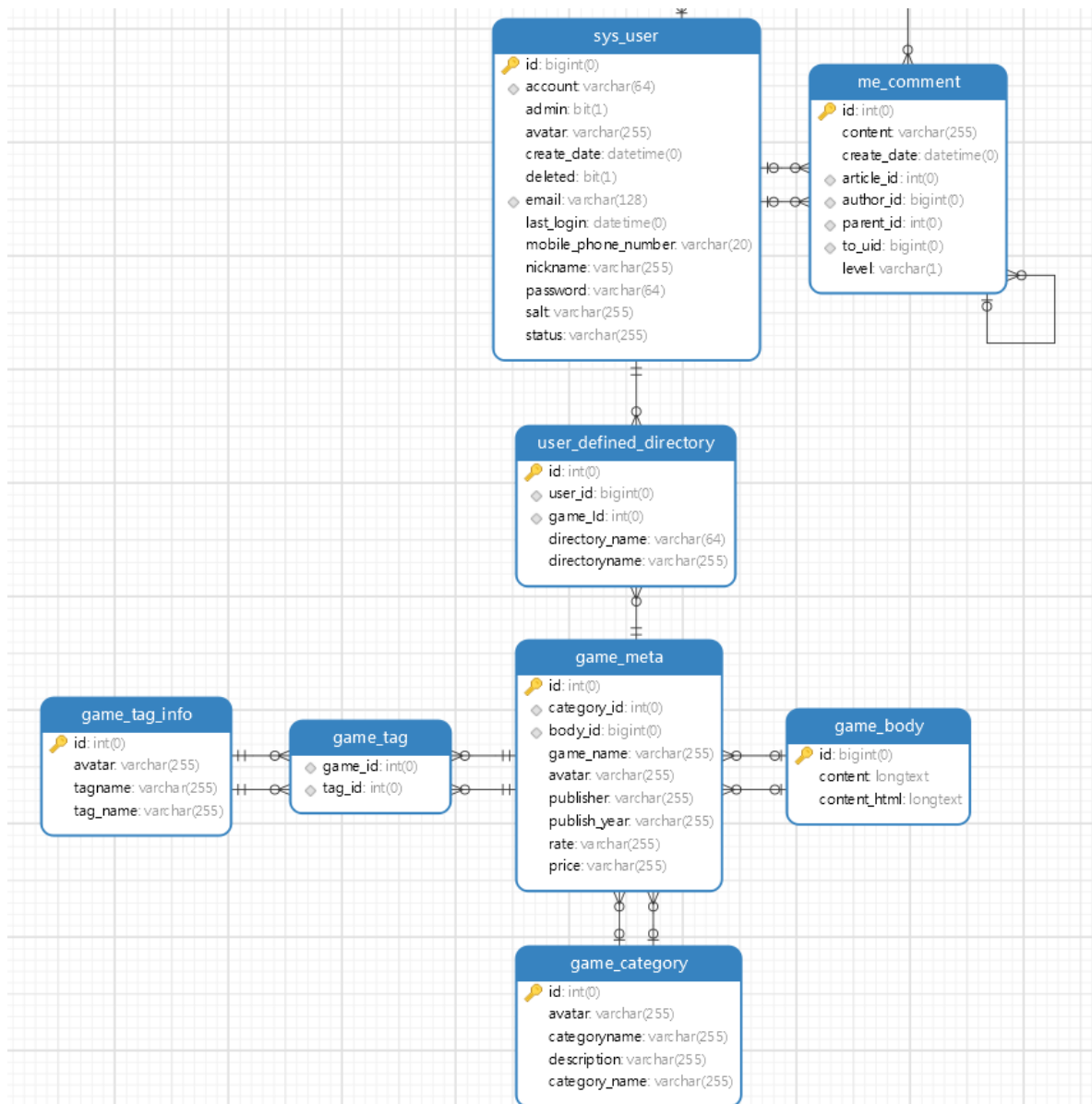


Figure 1.15: ER diagram and data dictionary 2 (connected to figure 1.14)

1.4 Software Architecture and Other Technical Methodology

1.4.1 Software Architecture

This project uses a separate development method of the front and back end. The front end uses **Vue.js** framework and the back end uses **Springboot** architecture.

To be specific, **Springboot** is committed to the booming rapid application development field. It is based on **Spring 4.0** design, which not only inherits the original excellent features of the Spring framework, but also further simplifies

the entire construction and development of Spring applications by simplifying configuration process.

In terms of the **Vue.js**, it is a progressive framework for building user interfaces. Unlike other heavyweight frameworks, Vue uses a bottom-up incrementally developed design. Vue's core library focuses only on the view layer, which is very easy to learn and integrate with other libraries or existing projects. On the other hand, Vue is fully capable of driving complex single-page applications developed with single-file components and libraries supported by the Vue ecosystem.

Back to this project, compared to the AngularJS + Springboot framework selected in Submission one, the architecture of this prototype application will be different in numerous aspects. The following figure will exhibit the architecture of the entire prototype.

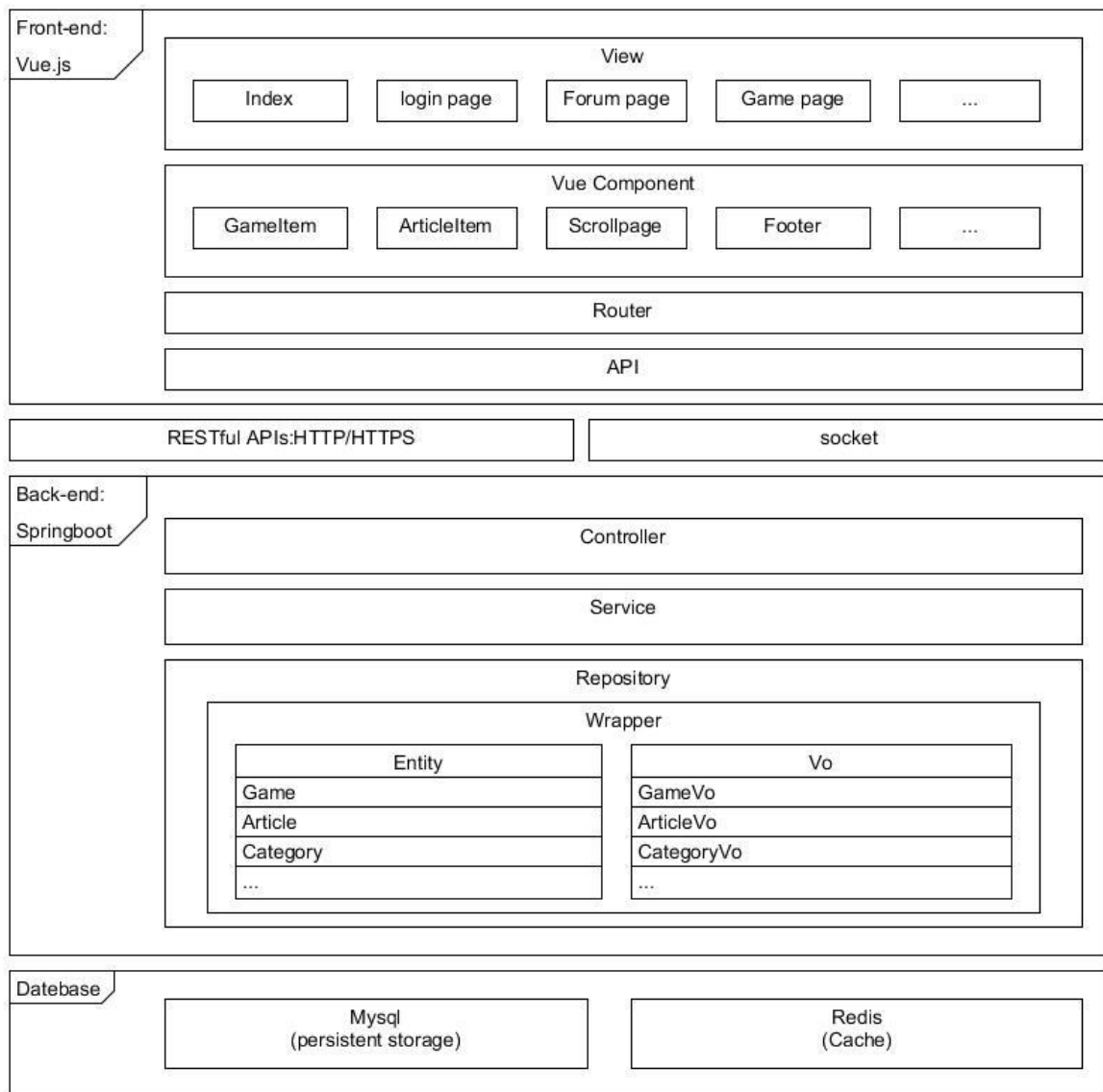


Figure 1.16: Software architecture for prototype applications

The overall software architecture is consistent with the **MVC** model. The analysis is based on the bottom-up order. The lowest layer is the database layer, which has been mentioned in the previous section.

Coming to the backend part (*./blog-api*), the Springboot back-end can be considered to have three layers: Repository, Service, Controller. The **Repository layer** (*./blog-api/src/main/java/com/shimh/repository*) is the data access layer, which contains the wrapper layer, while the wrapper layer contains the Entity layer and the Vo layer. Specifically, the Entity and Vo layers form a type of object, in which the Entity contains different attributes in the corresponding data table and the Vo contains some attributes that are not in the

data table but can be calculated or calculated by other attributes. In short, Repository layer reads data from different tables in the database and packs them into different objects as needed. Then, the **Service layer**(*./blog-api/src/main/java/com/shimh/service*) stores methods for these objects, such as finding articles by ID, games by category and so on. Finally, the **Controller layer**(*./blog-api/src/main/java/com/shimh/controller*) calls these methods which is defined in the Service layer and distributes data as json format to the API interface.

Regarding the front-end part, Vue has an **Api layer**(*./blog-app/src/api*) for receiving data from back-end and provides methods for other file calls on the front-end. In addition, Vue has a special **Component layer**(*./blog-app/src/component*) for building different components, which is convenient for the View Layer to call repeatedly. For example, game item was defined as a component for viewing the basic information about a game. Game category list page and favorites collection page can reuse this component, which makes development efficient. Finally, the user-oriented View layer calls different components to implement business logic, while the jump between pages is determined by the **Router**(*./blog-app/src/router*) .

1.4.2 Other Technical Methodology

Login via Token

In web applications, login maintenance has always been a complicated technical link. In our prototype, we implemented the login state maintenance and identity authentication mechanism through **Tokens**. The whole process follows the steps below.

1. When logging in, the client requests to log in with a username and password
2. The server receives a request to verify the username and password
3. If the verification is successful, the server will issue a token, and then send this token to the client in response.
4. The client receives the Token stored locally. Our prototype is stored in the session.
5. Each time the client requests the API interface like the server, it must bring the token.
6. The client should also verify the Token login status each time the route is redirected

7. The server receives the request, verifies the token, and returns data if it passes, otherwise it prompts an error message.

There are numerous advantages to using tokens. First, the token can be stored in any location (such as cookies or local storage, and the token is easier to cross domains). Second, when the token expires, we can keep the user logged in by refreshing the token. Finally, if the API is on different terminals, the token is more convenient and secure.

Shiro security framework

Shiro is a powerful and easy-to-use Java security framework that performs authentication, authorization, password, and session management. Our prototype application configures shiro on Springboot to implement permissions management functions. The main implementation method is to set a custom **Realm** domain to achieve a bridge between user data and Shiro data(*./blog-api/src/main/java/com/shimh/oauth*) . For example, user identity authentication and permission authentication are required to read data through Realm.

2. Usability test plan

2.1 Usability test preparation

2.1.1 Design a questionnaire

This is a questionnaire(<https://forms.gle/PWvyaU7yJtVYmVTL8>) provided for potential users to fill in after using the game collection website (Appendix A). The content of the questionnaire includes personal information, interests, operability, interface aesthetics and functional aspects. In personal information part, some questions about users' basic information will be set to filter the target users of the website. While questions of interests, operability and interface aesthetics and functional aspects are designed to help us know the attitude towards the website.

In order to have a better understanding of the evaluation of potential users on our website, questionnaire uses Likert scale to quantify the results. We will control the number of questions and the time of filling in the questionnaire will be within 2-3 minutes to avoid the user losing the patience of filling in the questionnaire.

2.1.2 Recruit volunteers

Since our platform is aimed at board game enthusiasts throughout Europe, N = 4 participants were recruited from the forum of the board game website.

We posted on the forum about volunteer recruitment with some introduction about our product. The main functions of our platform are board game collection management, social communication around board games, and recommendation of related games. The purpose of our recruitment of volunteers is to help us to carry out usability tests of the product prototype, so as to further improve the product. Also, the volunteers were restricted to Europe. Meanwhile, we also look for the board game fans around offline.

Due to the right approach to recruiting volunteers, our recruitment process attracted the attention of many board game enthusiasts, and a number of players

signed up to participate in the product usability test. After careful screening, we finally selected four volunteers with different background.

Although all the participants are fond of board games, not all of them were familiar with at least one board game collection and sourcing platform, including “Board Game Geek”, Board Game Squad’, ‘Board Game Finder’, etc. Fifty percent of participants were male, and the other fifty percent were female. The four volunteers were aged under 18, 18-25, 25-35, and over 35.

The first volunteer was a Caucasian male high school student from Greece under the age of 18. He often plays board games with his friends in his spare time, and he had his own board game club on one of the current board game collection and sourcing platforms as well.

The second volunteer was an Asian woman aged 18-25 who was living in the UK. She had an undergraduate degree and worked as a freelancer. She had much experience of using board game collection and management platform.

The third volunteer, a black man between the ages of 25 and 35 with limited experience in using board game collection and sourcing platforms, was working as a software development engineer for an Internet company in the Netherlands. He joined the company after he got a master's degree,

The last volunteer was a middle-aged man over 45 years old who lived in Italy and was of Caucasian ethnicity. He started working after high school and now works in a bar. Although he enjoys playing all kinds of board games, he has never used any board game collection and management platform.

After the selection of volunteers, we contacted the volunteers one by one and made an appointment with them for the product usability test. Since participants are living in different places, we decided to do remote testing using think-aloud protocol. In order to do so, we searched for a suitable software called “TeamViewer”, which can allow not only screen sharing but also video calls, in which way we were able to measure how long it took the participants to complete the task and record their response when completing the tasks.

2.1.3 Design think-aloud protocol evaluation plan

Secondly, we made preliminary plans for usability test. In order to ensure the reproducibility of usability testing and the smooth progress of testing procedure, we designed an instruction sheet (Appendix B), which included multiple tasks which participants need to complete during the test.

In addition, the “Participant Consent Form” (Appendix C) and the “Participant Information Sheet” (Appendix D) are also designed, which can ensure all the participants understand the purpose of this test, how their data will be protected, and some agreements that needs to be reached, such as being video recorded.

As for usability assessment methods, we selected appropriate measurement metrics from the two aspects, including user performance and satisfaction to measure the usability of the platform. As for performance, we decided to measure the degree to which users were able to successfully complete a task, including the time taken to complete each task. For user satisfaction, this metric relates to everything users say and think about when they complete each task. Therefore, we need to record the user's comments on the product during the test.

Since we plan to assess our board game collection and sourcing platform in both quantitative and qualitative way, two of our group members are responsible for carrying out the remote test using think-aloud protocol evaluation. Specifically speaking, one of our investigators are responsible for timing how long it takes for participants to complete each task, and whether they can successfully complete each task, together with observing the status of them. If a participant is evident anxiety depression, investigators should be immediately put an end to this particular task, and to encourage him/her to complete the remaining tasks. Another investigator is responsible for recording and taking notes about the participants’ comment during the test, such as the complexity of each task, the expected outcomes of each task, the evaluation of the product, and so on.

Regarding means of remote communication, we choose “TeamViewer” as the main tool to carry out the usability test. In addition, we found a software called “Xunjieshipin”, which can record the whole testing procedure including the screen, the voice from both system and microphone, so as to help supplement some results after the test.

2.2 Usability test implementation

2.2.1 Hand out questionnaire

We use Google Form to make a questionnaire. After that, we send the links and instructions of the questionnaire to various board game websites by posting, such as “BoardGameGeek”, “BoardGameSquad”, “Board Game Finder”, “Board Game Family” and boardgamequest.

Through a large number of questionnaires distributed in the board game websites, it is expected that we can collect more than 200 questionnaires.

2.2.2 Implement think-aloud protocol evaluation

Priority to completing any tasks, the participants are given the instruction sheet we designed in advance. Meanwhile, they are informed to read and fill in the “Participant Consent Form” and “Participant Information Sheet” carefully.

Participants are asked to express their ideas in real time during the task. This includes speaking of what they are doing, what they want to do, how sure they are of their decision, what is expected, and what is the reason behind the action.

During the testing process, participants could start the test when they are ready, and they are asked to read each task aloud first. Once they finished reading the task, one investigator is supposed to press the time stopwatch. The other investigator would focus on the participants' verbal expressions of doubt, disappointment, dissatisfaction, joy or surprise, their verbal expressions of confidence or indecision about the correctness of specific actions, and their non-verbal behaviors such as facial expressions. As soon as the participant reported they have completed the task, the investigator should stop the clock immediately.

When all the tasks are finished, participants are able to make further comments if they would like to. Finally, the testing procedure is finished.

2.3 Organize and store data

Delete redundant & invalid data

For the data of the interview, most of them are saved in video. So, in this part, there is no need to deal with the video.

As to data of the questionnaire, because our game collection website is mainly for Europe, we can filter out the data of potential users through the problem of "your permanent residence".

Through the two questions of "how interested are you in card games", "how much time do you spend on the card games (h/week)", we can know the user's time spent on the board games and whether they are interested in the card games. If the users spend less time on board games and are not interested in board games, then they are not likely to use our game collection website. The results of their questionnaire feedback are not so valuable to us, so we need to reduce their weight or delete them in the later analysis process.

Store data

In order to having more intuitive data viewing, we store the data to the xlsx file. The column represents each question in the questionnaire, and the row represents each question user to give a score (0-5).

In addition, we also classify the results in the questionnaire of interests, operability, interface aesthetics and functional aspects. Among them, the total score of interests is 20 points, the total score of operability is 30 points, the total score of Interface aesthetics is 10 points, and the total score of functional aspects is 15 points.

By calculating the user's score in each part divided by the total score of the corresponding part (normalization), we can get the user's favorite with each part of the website.

For four different participants, we will code their videos by No.1, No.2, No.3 and No.4. In addition, for the video data obtained through the participants, we decided to count the time used by the users to complete the above tasks and the number of times spent by the users to complete the tasks.

2.4 Results analysis plan

Research questions

The objective of this survey is to know the usability of our game collection website and find out changing which aspects can improve the usability of the website.

Datasets

We have two data sets, one is the result of the questionnaire, the other is the record the user's interviews (time of completing tasks and number of attempts finishing tasks). All members of our group have the right to get access to the data, but they have no right to modify the data. In order to ensure the objectivity of data and facilitate our use, we use the format of xlsx to store data, which means that we need to use Excel and other software, and the data will be saved in the format of text.

Variables

All processed data will be used in analysis. Among them, the dependent variable is the data in the interest part (after normalization); the independent variable is the data processed in the operability, interface aesthetics and functional aspects.

After finishing and recording the video, we have two variables: the time spent to complete the above tasks, and the number of times spent to complete the task.

Methods

Through the results of the questionnaire, we can know the scores of each part of interests, operability, interface aesthetics and functional aspects in the minds of users participating in the questionnaire.

By using the figures, we can complete the visual presentation of data that can be observed in each problem, and use statistical information to generate the numerical description of data. After that, we choose the appropriate figures (pie chart or bar chart) to represent the specific data set, which depends on the measurement level of the variable.

For the interviews, we can find the user's satisfaction at each task by observing their comments, their mood changes and basic statistics. Then we can judge whether the usability design of the task needs to be modified.

3. Usability analysis

3.1 Questionnaire

3.1.1 Describe the process

According to the original usability test plan, we will send the questionnaire and the purpose of the questionnaire in the form of posts on the five websites of 'BoardGameGeek', 'BoardGameSquad', 'BoardGameFinder', 'TheBoardGameFamily', 'BoardGameQuest'. We have created posts about the questionnaire in top 10 forums of each website. But after a week of waiting, we received 27 questionnaires.

However, the number of questionnaires received is not as good as expected, and the discussion about the questionnaire is relatively low. We will send another post about the questionnaire in each website's new 10 forums. At the same time, we turned our attention to Facebook social application. Our team members sent out questionnaires on their own Facebook. In addition to this method, we also found and joined 'Boardgame and Roleplaying for sale UK and EU', 'Board Game Exchange-Buy, Sell&Trade Your Boardgames', 'Edinburgh Board Games Group', 'The BOARDGAME GROUP', and 'Board Games & Roleplaying Games Buy & Sell UK &EU ONLY!' of Facebook. In these groups, we sent out our questionnaires. Finally, we received 286 questionnaires.

3.1.2 Results

In the design of this website, the users of the website are set as Europe to avoid the differences caused by different cultures. Therefore, in this questionnaire, we only filter out the feedback of "permanent residence" with "Europe" and "preference not to say". In addition, our website is designed to provide users who like playing board games with collection management functions and help them find playmates through forums and clubs. Therefore, we have to continue to filter people who are not only interested in board games but also have time to enjoy it. Thus, we choose the users who answered "how much time do you spend on the card games (h / week)" for more than 5 hours and "how interested are you in card games" for more than 3 (neutral).

In this survey, we received 286 questionnaires. After the above filtering, we have obtained 215 valid questionnaires from whom are all interested in card games.

Descriptive analysis of personal information

From Figure 3.1, we can see that, in the questionnaire, the age groups of our main users are 36-45 (29.4%), 26-35 (23.5%) and 19-25 (23.5%). By comparison, the 0-18 age group and the over 45 age group have fewer people interested in board games. From Figure 3.2, we can see that most of the potential users of the website are male or female. It also shows that there is no obvious gender preference in this activity. From Figure 3.3, we can see that 41.2% of the users participating in this questionnaire have master's degree or above, followed by high school's degree. In addition, 5.9% of users are reluctant to disclose their education background.

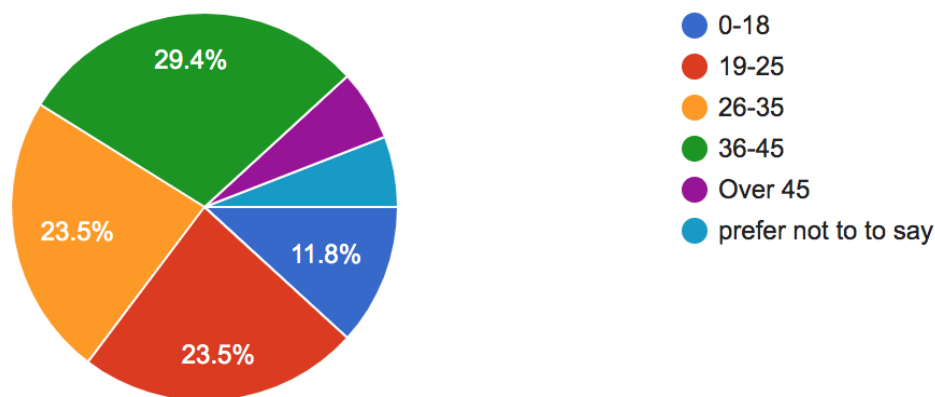


Figure 3.1: Pie chart about the users' age in the questionnaire

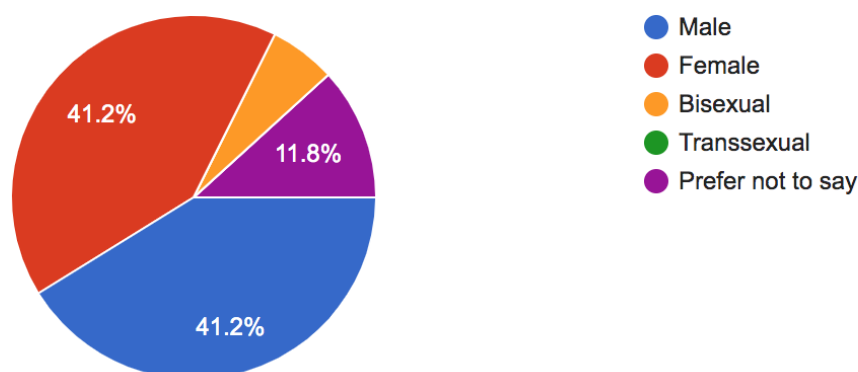


Figure 3.2: Pie chart about the users' gender in the questionnaire

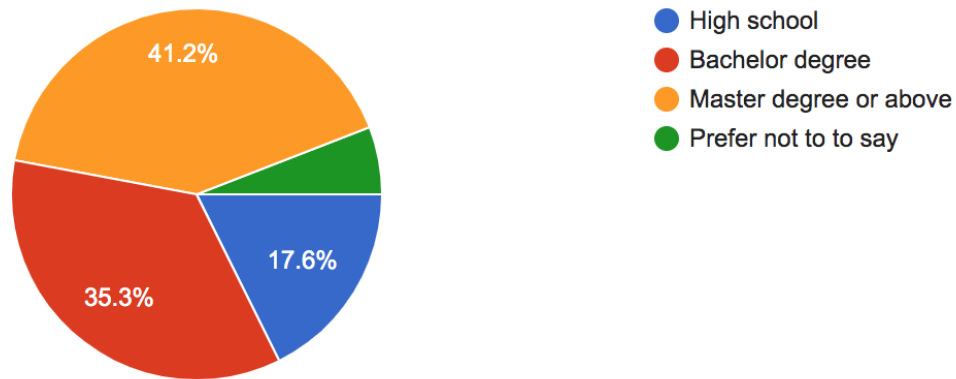


Figure 3.3: Pie chart about the users' education in the questionnaire

Interests

In this section, we asked users about interests on our game collection platform. The questionnaire was used the Likert scale to have a better understanding of users

- How interested are you in our website;
- I think this website is valuable;
- I will use this website in the future;
- I will recommend this website to my game friends.

By filling in these questions, users can express how much they like our website in general. The larger the total score of this part given by users, the higher their interests on the website.

There are four questions in this part, with a total score of 20 points. Table 3.1 calculates the average, median, standard deviation, minimum and maximum values of 215 users.

Mean	Median	SD	Min	Max
13.8	15.0	1.7	5	20

Table 3.1: Basic statistics of interest part

The data in Table 3.1 and the survey give information about that most users are interested in our game collection website, many of them are given 18, 19 and 20 score in this part. But SD 1.7 also indicates that there are some users who are not

very interested in our website. There are also users who give the lowest score for each question.

Operability

The questionnaire of Operability part is to investigate whether the game collection website is easy to operate and understand for users. In other words, whether users know how to operate the website for the first time without any expert or any guide.

In the section, the questions we ask are all about the user's operability to our game collection platform. We still used the Likert scale in this part.

- This website is easy to use;
- I am confident about using the website;
- This system is NOT unnecessarily complex;
- After several operations, I can finish the works I want to do quickly;
- I know the result of any operation on the website;
- I think the operation of this website is very simple.

The high score given by users in this part indicates that our website is better in easy operation.

There are six questions about operability, and the total score of this part is 30 points. Table 3.2 is the basic statistics about whether the website is easy to operate.

Mean	Median	SD	Min	Max
25.3	24.0	0.9	20	30

Table 3.2: Basic statistics of operability part

Combining Table 3.2 with the data obtained from the survey, we got feedback from our users that our website is easy to use. It is shown that in the operability part, the general users give high scores. The low value of median also indicates that most users have relatively high evaluations of the operability of website. For our survey users, when they use this website, they can understand and use it well without the help of the outside world.

Interface aesthetics

This part of interface aesthetics is a question set up to investigate whether a web design is aesthetically pleasing. Because the website page is a direct factor in attracting users' attention. We design the following two questions.

- I think the layout of this website is very suitable
- I think the design of this website is pretty

Through interface aesthetics, we have collected ratings on whether our website pages are aesthetically pleasing. Similarly, a higher score indicates that this part of the web design is more aesthetically pleasing. In this section, there are two questions. The total score is 10 points. Table 3.3 is the basic statistics about the score of this part.

Mean	Median	SD	Min	Max
5.2	6	2.3	3	10

Table 3.3: Basic statistics interface aesthetics part

According to the standard deviation and median in Table 3.3, we can find out that the user's differences is a little large in terms of interface aesthetics. For example, some users gave full marks, while others gave very low marks. This also illustrates that this page can continue to find specific improvements by using other methods, such as interview.

Functional aspects

The functional aspects part of the questionnaire is to understand whether the function implemented of our website meets the user's expectations, or that it meets all the functional requirements that users want. We have designed three questions about how well a website is functioning.

- I think the various functions on this website is well-integrated
- I do not think there is too much inconsistency in this website
- I think this website has all the functions I want

Similarly, we add user ratings to these three questions. The higher the score, the better the functionality of our website. Table 3.4 shows the status of our website regarding the completeness.

Mean	Median	SD	Min	Max
5.6	5	0.9	3	11

Table 3.4: Basic statistics of functional aspects part

From this part of the feedback, it is shown that users think the functions of the website cannot meet their needs. The lowest score is 3, which means that the users do not think the implemented function can provide them with the desired functions. The score of this part mainly focuses on low score, and the difference between good score and bad score is not large. This also reveal that this part has a lot of room for improvement.

Comment

The last question of the questionnaire is to ask users for suggestions on our game collection website. Since the last question is not required to be answered, we have not collected many reviews. However, after our group's discussion, our main opinions are about the time function of the website is relatively small, not very comprehensive, and the UI interface design is a little simple, leaving too much white space.

The last question of the questionnaire is to ask users for suggestions on our game collection website. Since the last question is not required to be answered, we have not collected many reviews. However, after browsing and discussing in our group, our main opinions are that the website implements relatively few functions, is not very comprehensive, and the UI interface design is a bit simple, leaving too much white space.

3.1.3 Conclusions

According to the method introduced in chapter 2.3, we calculated the satisfaction of each user with the four parts of the website (interests, operability, Interface aesthetics, functional aspects). That is, the total average number of scores given by users in this part divided by the full score of this part is the user satisfaction of this part.

Interests	Operability	Interface aesthetics	Functional aspects
69.0%	84.3%	52.0%	37.3%

Table 3.5: the satisfaction of the four parts

From table 3.5, we can see that most users think our game collection website is a very easy to operate website, and also has a relatively high interest on this website. However, from the survey results, both Interface aesthetics and functional aspects need to be improved.

3.2 Think-aloud protocol evaluation

During the testing procedure, we realised that sometimes participants would make comments after encountering some impressive points for a long time, which resulted in inaccurate measurement of time, excessively long conversations between investigators and participants, and less efficient completion of tasks. Therefore, we decided to let the user remain silent while the task was being executed, and express their feelings and thoughts when the task was completed. Because each of the tasks was relatively short, there was no situation where the participant could not remember the thoughts that had occurred at the time.

Since the sample size of think-aloud protocol evaluation is limited, the data were only analysed descriptively. Qualitative data were represented by participants' comments after each task and after the whole testing procedure.

Table 3.6 shows the efficiency of each participant in completing each task, measured in terms of time in seconds spent, together with the total time to finish all tasks.

	Task 1 [sec]	Task 2 [sec]	Task 3 [sec]	Task 4 [sec]	Task 5 [sec]	Total [sec]
Participant 1	25.34	21.58	8.33	14.58	32.70	102.53
Participant 2	29.12	63.90	16.75	32.42	41.61	183.80
Participant 3	23.79	16.01	10.48	25.24	29.25	104.77
Participant 4	35.62	43.25	26.27	56.27	74.23	235.64

Table 3.6: Time-on-task data of each participant

Table 3.7 presents the summative data of the time of participants in completing one particular task and all tasks, including average, median, maximum, minimum and standard deviation.

	Average	Median	Max	Min	SD
Task 1	28.47	27.23	35.62	23.79	5.27
Task 2	36.19	32.42	63.90	16.01	21.90
Task 3	15.46	13.62	26.27	8.33	8.04
Task 4	32.13	28.83	56.27	14.58	17.69
Task 5	44.45	37.16	74.23	29.25	20.53
Total Tasks [sec]	156.69	144.29	235.64	102.53	64.80

Table 3.7: Summative data of time-on-task.

Table 3.8 shows the typical comments made by the participants on the platform prototype during the completion of the task and at the end of all the tests.

	During the task	After the whole test
Participant 1	<ol style="list-style-type: none"> 1. The website is supposed to prompt me what is my username. 2. It may be better if I can quickly search a game rather than only have to find the game in the categories. 3. I like the categories on game page, which can help me better look at different games. 4. The game tags are useful. 5. It is easier than I think to create a post. 6. Replying others' comments is simple. 	<ol style="list-style-type: none"> 1. The whole website is clear and easy to learn. 2. Maybe you can add more social functions to this website, like add new friends, or clubs that can allow users to play together offline. 3. The speed of completing multiple tasks is very quick. 4. I would like to become your first user!
Participant 2	<ol style="list-style-type: none"> 1. The register process is quite easy. 2. I don't know what my username is, because I tried the account first, but it did not work. And I could not retrieve my username. 3. The categories and tags can help me find games more targeted. 4. I thought there would be a list of all the forums I can search. 5. Posting is easy, but I spent pretty long time to find what I just posted. 6. It is hard to find how I can reply to other users' posts, because the color of reply button is too light. 	<ol style="list-style-type: none"> 1. Some tasks are hard to complete, maybe it is because I do not have the experience of using a game collection platform. 2. I like the simplicity and clarity of the site. 3. Seems like I can do lots of things using this platform. 4. It would be good to make new friends or contact current friends using this platform.

Participant 3	<ol style="list-style-type: none"> 1. It is good that I can see different types of board games. 2. Using the game subpage to find a board game is convenient, however it is better if there is a search box on homepage that can search for anything. 3. I thought I could see a list of all the games in game subpage, regardless of which categories or tags they are in. 4. Creating a post is quite difficult to learn. For example, not all the tags can I understand what the meanings. 5. I found a mistake in my reply, but I can't delete it. 	<ol style="list-style-type: none"> 1. I like the home page of the website. 2. Generally speaking, the website is easy to learn for me, but maybe difficult for those who don't have the experience of using similar websites. 3. You can add more prompt to help those inexperienced users. 4. The most notable part is that the operation process was smooth and there was no slow storage.
Participant 4	<ol style="list-style-type: none"> 1. The register process is simple and straightforward. 2. I can easily sign in the system. 3. The process of finding the game was easy, and I think the game page presented games in a very comprehensive way. However, some words are a little small in size. 4. The home page is exactly what I thought in mind. 5. I did not know what tag I should choose, and what to write in "Abstract" part. 6. I could not find where to reply others' comments in the beginning. 	<ol style="list-style-type: none"> 1. I like the style of the platform, and it made me want to use the platform to search for new board games and make friends. 2. The speed of the platform looks fast. 3. It is hard for me to complete some of the tasks. 4. I sometimes forget which page I am in. 5. Maybe you can add more prompts to teach me how I can use this platform.

Table 3.8: Comments from the participants during and after the test

Results Analysis

Regarding the results of the time required to complete the task, we found that the time required to complete the task by using the platform varied greatly among participants from different backgrounds. The tasks with big difference in time are mainly login function, post function, reply function and delete reply function. We have noticed that participant 1 and 3 have not only passion for board games, but also experience of using similar platforms. Participant 2 and 4, by contrast, didn't have the experience of using similar platforms, which lead to a speculation that the use of similar platforms is an important factor in determining whether users can complete tasks quickly. At the same time, in comparison, participant 4 took longer time to complete almost all tasks than the other three participants. We speculated that it was because investigator 4 was relatively older and its operation speed was relatively slower than that of younger participants.

As for the comment records, all the participants gave positive comments on the platform's home page. Also, the speed of page jumping and data storage was rated favorably by almost all participants. What's more, for the sub-page of the game, most of the participants praised the classification of the game designed by the platform, including classification by category and by label. After the testing procedure, most participants were interested in the overall style of the platform's prototype and expressed their hope to see the platform finally go live.

However, the platform still has some notable usability issues in some designs. For example, participant 2 did not know whether or not the user name should fill out the account name, participant 1 and 3 hoped the platform can provide a search box, in order to search games and other items more convenient, three participants said the function of post has some confusion on the tag selection, for some of the meaning of the tags are not easily understand without an explanation. One participant addressed that she sometimes forgot where she was, which underlines that we should keep informing users about the subpage they are in. For example, the button style for the current page should always be different from the other button styles.

In addition, participant 4 indicated that some of the font size was a little small, while participant 2 believed that the color of the reply button was a little light, which inspired us to check whether fonts, images and buttons on every pages are easy to read and found.

After the completion of the whole test, participant 2 and 4 indicated that they had encountered some difficulties in completing some of the tasks, which was speculated to be caused by the lack of previous experience in using relevant platforms. Meanwhile, the comments from participant 3 also confirmed our guess. They said maybe more tips could help them better understand the platform's functions, so as to learn to use the platform more quickly. In addition, after the survey, the majority of participants wanted the platform to provide social functions, expressing their desire to see a improved platform that have richer functions.

4. Prototype and project evaluation

4.1 Prototype evaluation

4.1.1 Function evaluation

The prototype has involved the main functions listed in the original design criteria set out in the last submission. The login & register function, game display function, collection display function, and community function are implemented in this prototype. Moreover, we provide the home webpage, which presents the most popular and recently published posts on this website. However, due to the time limitation, we didn't achieve club function, personal profile function and recommendation function. Those functions are planned to be implemented in future development. From the perspective of functional requirements design, Table 4.1 presents the detailed functions that we achieved and other functions we haven't achieved.

Module No.	Function Module	Function Name	Completed or not	Altered or not	Development details
1.	Register and Login	1.1 Register	Yes	No	The basic register is achieved. The register information required is the username, account name and password.
		1.1.1 Email address verification	No	No	No email verification is provided.
		1.1.2 Username and password retrieve	No	No	To simplify the prototype, password cannot be retrieved.
		1.2 Login	Yes	No	User can login to the system by entering the username and password.
2.	Collection management	2.1 View game in 'my collection'	Yes	No	The user can view his collected games in the 'collection' area categorized by labels; When the user clicks some game, the website will jump to corresponding game information page.

		2.2 Manage a directory	No	No	Due to technical difficulty and time limitation, we didn't achieve these functions for this prototype.
		2.3 Search games in 'my collection'	No	No	
		2.4 Add games to 'my collection'	No	No	
		2.5 Remove games from 'my collection'	No	No	
3	Game display and search	3.1 Game lists display	Yes	Yes	The user can look for games by their categories and labels. Moreover, the game whose rate is more than 8.0 will be presented firstly in the game list. However, there is no search function provided.
		3.2 Display popular games	No	Yes	The user can see popular labels, popular posts and recent published posts once he enters the platform, instead of games.
		3.3 New game recommendation	No	No	The game recommendation algorithm is not provided.
		3.4 Display one specific game	Yes	No	When the user clicks a specific game, the website will jump to the game information page, which includes game's name, introduction, label, categories, avatar, publish_year, publisher, rate and price.
		3.4.1 Share a game	No	No	Due to time limitation, we need to focus on main functions' implementation. Therefore, no share function is provided.
		3.4.2 Similar games recommendation	No	No	No game recommendation is provided.

4	club search and management	club search, display popular clubs nearby, join clubs, display posts from club members, quit clubs, create a club, manage applications from clubs...	No	No	Due to time limitation, we didn't develop club function.
5	Communities: Friends	Nearby friend recommendation, search new friends, send friends adding request, friend management, share game and rules, chat with friends	No	No	We didn't provide social function because of the limited time and the limited number of developers.
	Communities: Public forum	5.1 Add 'my forum'	No	No	The user cannot add forums to follow
		5.2 Remove 'my forum'	No	No	The user cannot remove his forums
		5.3 Write a post	Yes	No	Once the user logs in the system, he can write a post and choose its forums and labels, then submit to the system.
		5.4 Edit the published post	Yes	Yes	The user can edit his posts after the post is published.
		5.4 Post information display	Yes	No	The user can scan the post's publish time, view number, comment number, publisher, content, categories and labels. When the user click the post's forum and label tag, the website can jump to the forum page where all posts related are listed.
		5.5 Posts management	Yes	No	The posts are listed by their forums and labels.
		5.6 Submit a comment to the post	Yes	No	The user can send his comments to the post, and the comment bar below the post will display his comments. If the user doesn't log in, he cannot comment the post.
		5.7 Delete my comments	Yes	No	The user can delete his own comments, and other users are not allowed to delete others' comments.

		5.8 Send notifications	No	No	The user cannot receive notifications about his comments and replies
		5.9 Posts recommendation(new function)	Yes		In the home page, the recently published posts, and popular posts are presented.
6	Game rating system	Display composite score from multiple board game platforms, comment on and score the game, display comments and scores of the game, ignore certain comment sources, manage own comments	No	No	We didn't develop game rating system due to time limitation.
7	Personal profile management	Change password; Management my account, view clubs and friends, view my forum, system setting management	No	No	We didn't have time to provide these functions
		log out the account	Yes	No	The user can log out the system, and all his information, posts and comments are saved in the system

Table 4.1: The comparison between original requirements design and implemented prototype

4.1.2 Software design evaluation

For this coursework, we mainly focus on the back-end and front-end design to ensure that our system's safety, stability and users' information security.

Following the software design presented in the last coursework, we applied front-end and back-end separation development mode. In this way, the back-end is only responsible for providing APIs required, and the front-end has various methods to process the data and presents webpages.

We basically followed the implementation paths: Spring Boot as the back-end framework, MySQL database for storing tables and Redis databases for caching users' sessions. However, we changed the front-end framework from AngularJs to Vue.js since our developers are more familiar with the Vue.js framework. The comparison between the original and implemented software design is presented in Table 4.2. It's worth noting that we added many new frameworks to help us achieve complete front/back-end development.

As for the front-end, we used Vue-router to achieve dynamic router matching and Vuex as the state management pattern to help us to deal with the condition when we have multiple components sharing a common state. We also employed ElementUI's modules to build the user interface design of our website, and Lodash, a javascript tool library to quickly complete the js construction. Moreover, Axios is applied for intercepting requests and responses and Webpack to pack all js files.

For the back-end, apart from applying Spring Boot, we employed many other frameworks. For example, Shiro is a powerful and easy-to-use Java security framework that performs authentication, authorization, password and session management. Besides, we used JPA(Java Persistence API) to describe the management of relational data in applications.

Overall, we put a lot of effort into front-end and back-end development. The data presented on the website are all from the MySQL database and obtained from the back-end APIs. This convenience helps us to develop more functions easier in the future.

Module	Original software design	Implemented software desgin
Architecture	Model View Controller	Model View Controller
Front-end	Angular.js framework	Vue.js framework
		Vue-router
		Vuex
		ElementUI

		Lodash
		axios
		webpack
Back-end	Spring Boot framework	Spring Boot framework
	Log	Shiro
	DAO(Data Access Object)	Jpa(Java Persistent API)
	Mybatis ORM(Object Relational Mapping)	Fastjson
		Druid
Database	MySQL, Redis	MySQL, Redis

Table 4.2: The comparison between original and developed software design

4.1.3 User interface evaluation

For the user interface, as mentioned before, we used ElementUI to achieve web design. In the prototype, the layout is similar to the original design.

Same as ever designed, We provide ‘Home’, ‘Game’, ‘Collection’, ‘Community’, ‘Login’ and ‘Register’ in the main bar. In addition, the ‘Write a post’ button is also presented in the bar’, which allows users to write a post conveniently. When the user doesn’t log in and click it, the website will prompt him to log in or register.

In the ‘Game’ component, we altered the ‘Game Search’ and ‘Personal recommendation’ components to ‘Game category’ and ‘label’. The user can scan the number of games in each category and label and search for a game by scanning the game lists for each category and label. For each game, the name, picture, rate, price, publisher, and published_year are presented with a clear layout.

For the collection part, we designed a vertical directory displaying all directories the user has created, and the right side is the game list for each

directory. Compared to the original design, we didn't use the directory's covers in order to reduce the webpage number and make the collection more clear.

The 'Community' part used the same layout as 'Game'. The user can scan all forums and their post number by clicking 'forum'. Besides, the user can also click the 'type' button to scan the posts sorted by different post types, such as Reviews, Rules, Strategy, Version and General.

The 'Club' and 'Personal Profile' components are not provided in this prototype,

4.2 Further development plan

For the further development of this website, an outline plan has been made. In order to develop a high-quality website, we will mainly focus on achieving more detailed functions in 'Game', 'Collection', 'Community' and 'Personal Profile' components. We also want to add email verification function to enable users to retrieve their accounts. Table 4.3 is the plan for further development.

Component	Functions to be achieved	Function description	Estimated development time
Game	Game searching	A search bar will be provided for users to search the game	5 days
	Similar game recommendation	A similar game recommendation algorithm will be provided. When the user scans a game, the similar games with the same category or label will be listed below the game introduction.	5 days
	Game rating and reviews	Users will be allowed to rate the game and leave their comments. The overall score will be calculated by the weighted average score among all scores.	5 days
Collection	Collection management	Users will be allowed to add games to their collections by directories and remove them freely.	10 days
	Game searching in the collection	Users can search collected game in 'collection' component.	3 days
Community	Forum searching	Users can search a specific forum among all forums.	3 days
	Post searching	Users can search a post among all posts. The results are the posts ranked by their relativity.	3 days

	Follow a forum	The user can follow a forum, and the forum can be shown in the 'Personal Profile' -'My forum list' component.	5 days
	Unfollow a forum	The user can unfollow a forum and it will be removed from 'My forum list'	5 days
Personal Profile	My forum list	The followed forums will be listed here.	5 days
	My posts	The posts created by the user will be listed here.	3 days
	Account management	The user can edit his username, avatar, password.	5 days
Login/ Register	Email address verification	The user can verify his identity by inputting the code which is sent in the email.	14 days
	Username and password retrieve	When the user forgets his username or password, he can retrieve them by email verification.	8 days

Table 4.3: the further development plan

4.3 Project evaluation

During developing this prototype, we met many problems with time estimation and task allocation. In general, we completed this prototype, but many functions were not achieved due to many factors.

For the prototype development allocation, we altered the work plan for each developer. Tiffany Shao and Congyu Cai were responsible for the front-end design, and Weihang Li and Xinyue Sheng did the back-end work, since Tiffany and Congyu know more knowledge about building Vue.js, and Weihang and Xinyue is proficient in Spring Boot construction and designing MySQL database. In this way, we could build our prototype efficiently.

For the usability and evaluation work, Congyu and Tiffany were assigned to design the usability plan and analysis the results, Xinyue was responsible for prototype and project evaluation and Weihang was allocated to write down the developed prototype design. These assignments are not included in the previous work plan.

After reassessing our time budget and capabilities, we realized that there are too many functions required in the project plan and it is almost impossible for us to achieve all of them. Therefore, we decided to target basic functions and leave the remaining functions for future development. We focused on the overall

development of back-end and front-end, authority management and users' information security, providing a solid foundation for subsequent development.

Time budgeting is another key issue in this development process. Due to the lack of Spring Boot development experience, back-end work was delayed by 10 days. In addition, due to the spread of COVID-19 in the UK, a member of our team left the UK to return to her country and her work was postponed. For a few weeks, we were all anxious and panicked, and it affected overall productivity.

In short, we didn't completely follow the original work plan. Although facing many difficulties, we basically build the prototype successfully. The remaining functions are planned to be achieved in further development.

Appendix

A. Questionnaire



Questionnaire about Game Collections Management and Sourcing System

Thank you for your precious time to participate in the questionnaire survey of the game collection website. Please complete this questionnaire after you use the website. This questionnaire will include your personal information, interests of the website, usability of the website and your suggestions for the website. This website is expected to take you 2-3 minutes.

Personal information

Please feel free to fill in your personal information. We will never disclose your information to any third-party.

Age *

- ☐ 0-18
- ☐ 19-25
- ☐ 26-35
- ☐ 36-45
- ☐ Over 45
- ☐ prefer not to to say

Gender *

- ☐ Male
- ☐ Female
- ☐ Bisexual
- ☐ Transsexual
- ☐ Prefer not to say

Education *

- ☐ High school
- ☐ Bachelor degree
- ☐ Master degree or above
- ☐ Prefer not to say

Your permanent residence *

- ☐ Europe
- ☐ Asia
- ☐ America
- ☐ Oceania
- ☐ Africa
- ☐ Prefer not to say

How much time do you spend on the card games (h/week) *

How interested are you in card games *

	1	2	3	4	5	
Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	High

Interests

How interested are you in our website *

	1	2	3	4	5	
Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	High

I think this website is valuable *

	1	2	3	4	5	
Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Agree

I will use this website in the future *

	1	2	3	4	5	
Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Agree

I will recommend this website to my game friends *

	1	2	3	4	5	
Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Agree

Operability

This website is easy to use *

	1	2	3	4	5	
Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Agree

I am confident about using the website *

	1	2	3	4	5	
Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Agree

This system is NOT unnecessarily complex *

	1	2	3	4	5	
Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Agree

After several operations, I can finish the works I want to do quickly *

	1	2	3	4	5	
Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Agree

I know the result of any operation on the website *

	1	2	3	4	5	
Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Agree

I think the operation of this website is very simple *

	1	2	3	4	5	
Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Agree

Interface aesthetics

I think the layout of this website is very suitable *

	1	2	3	4	5	
Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Agree

I think the design of this website is pretty *

	1	2	3	4	5	
Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Agree

Functions

Education *

- ☐ High school
- ☐ Bachelor degree
- ☐ Master degree or above
- ☐ Prefer not to say

Your permanent residence *

- ☐ Europe
- ☐ Asia
- ☐ America
- ☐ Oceania
- ☐ Africa
- ☐ Prefer not to say

How much time do you spend on the card games (h/week) *

B. Participant Instructions

Instructions

As designers, we want to do our best to provide users with a platform with strong usability. Don't be nervous if you encounter a problem during testing, because it may be something we didn't notice when we designed it, and it's not your fault.

Imagine you are a new user who want to use this board game collection and sourcing platform, there are multiple functions the platform can provide. You are given several tasks to complete, which are the most important functions the platform provides.

In prior to the start of a task, you can tell us possible result this task is expected to achieve. In the process of completing the tasks, you can give oral comments at any time. The comments may include how easy it is to finish this task, is there a confusing place. In the end, you are advised to tell us whether the result is same as expected. We will improve our system according to your feedback.

Task 1

Please register an account on the platform.

Task 2

After registering, please sign in the platform.

Task 3

Please find games that needs 60-120 minutes to play.

Task 4

Please create a new post.

Task 5

Please write a comment to other's post, and then find it.

C. Participant Information Sheet

Who are the researchers?

The researchers include all the four members of the project development team.

What is the purpose of the study?

The main purpose of this study is to collect feedbacks about using the platform prototype, discover usability problems that were not noticed during development, so as to improve platform usability.

Why have I been asked to take part?

The target group of our research is people who have passion for board games among Europe.

Do I have to take part?

No – participation in this study is entirely up to you. You can withdraw from the study at any time, without giving a reason. Your rights will not be affected. If you wish to withdraw, contact investigators. We will stop using your data in any presentations submitted after you have withdrawn consent. However, we will keep copies of your original consent.

What will happen if I decide to take part?

During the test, our investigators will guide you and facilitate the test through video and screen sharing.

First, you will be asked to complete a number of tasks using the prototype of the platform. Also, you will be encouraged to give comment about the platform during the test. The whole process will take only once, about half an hour, during which time we will record the video of process of the test to help the investigators to supplement the results later. But don't worry, we will not disclose any information about you to the public.

Since the test is done remotely, you can participate at any time, in any place, as long as you have a computer on hand.

Are there any risks associated with taking part?

There are no significant risks associated with participation.

Are there any benefits associated with taking part?

There are no special benefits associated with participation.

What will happen to the results of this study?

The results of this study are only used to analyse the usability of the platform prototype and to develop different versions of the platform. Your data may be archived for at least 2 years.

Data protection and confidentiality.

Your data will be processed in accordance with Data Protection Law. All information collected about you will be kept strictly confidential. Your data will be referred to by a unique participant number rather than by name. Your data will only be viewed by the development team.

All electronic data will be stored on a password-protected encrypted computer. Your consent information will be kept separately from your responses in order to minimise risk.

What are my data protection rights?

You have the right to access information held about you. Your right of access can be exercised in accordance Data Protection Law. You also have other rights including rights of correction, erasure and objection. Questions, comments and requests about your personal data can also be sent to the investigation team at s1922346@ed.ac.uk.

Who can I contact?

If you have any further questions, complaint about the study, please contact the investigation team, Tiffany Shao at s1922346@ed.ac.uk, Congyu Cai at s1926848@ed.ac.uk.

When you contact us, please provide the study title and detail the nature of your complaint.

D. Participant Consent Form

Please tick yes or no for each of these statements.

		Yes	No
1.	I confirm that I have read and understood the Participant Information Sheet for the above study, that I have had the opportunity to ask questions, and that any questions I had were answered to my satisfaction.		
		Yes	No
2.	I understand that my participation is voluntary, and that I can withdraw at any time without giving a reason. Withdrawing will not affect any of my rights.		
		Yes	No
3.	I agree to being video recorded.		
		Yes	No
4.	I consent to my anonymised data being used in academic publications and presentations.		
		Yes	No
5.	I understand that my anonymised data can be stored for a minimum of two years		
		Yes	No
6.	I allow my data to be used in future ethically approved research.		
		Yes	No

7.	I agree to take part in this study.		
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Name of person giving consent		Date		Signature
		dd/mm/yy		
Name of person taking consent		Date		Signature
		dd/mm/yy		