Design and Implementation of JAVA-based Project Management Platform for College Students' Innovative Entrepreneurial Training Program

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Abstract-In the wake of the expansion of the scale of innovation and entrepreneurship training programs for college students and the continuous increase of resources invested in colleges and universities, the previous offline management methods and modes have greatly hampered the improvement of project quality and management efficiency. Based on concept and practice of the whole process management of the innovation and entrepreneurship training program for college students in University A, this paper designs and builds a project management platform. Underpinned by B/S layered architecture, this paper uses Django as the web framework, Bootstrap as the front-end design style, Echarts as the visual plug-in, MySQL as the database support, and utilizes the MVC design pattern design to achieve two-way data binding. Through the running practice to prove, the platform fulfills the information management of the whole process of the project, the visual display of data, and the intelligent recommendation of the project, which improves the efficiency of project management and provides a certain reference significance for the design of the project management information platform similar to the management workflow.

Keywords: Project management platform; Intelligent recommendation; Data visualization; Collaborative filtering algorithms; Modularization;

1 INTRODUCTION

College Students' Innovative Entrepreneurial Training Plan Program is one of the key construction projects of the undergraduate teaching quality and teaching reform project in colleges and universities, serving as an important grip on colleges and universities to promote and deepen the reform of innovation and entrepreneurship education. At present, this program has covered more than 1,000 colleges and universities across the country, with a total of about 2.7 million projects approved and more than 10 million undergraduates participating. It is the innovation and entrepreneurship education project with the longest history, the widest coverage, and the greatest impact in China. With the continuous expansion of the resource input of various universities and the scale of student participation, the comprehensiveness and complexity of project management have also increased exponentially. Although most colleges and universities have improved the quality and efficiency of project management through informatization, they are limited to project process management and personnel management and lack further utilization of data. In this context, it is exigent to solve the problem of how to use the data accumulated by this platform (College Students' Innovative Entrepreneurial Training Plan

Program) for analysis and enable the platform to be more intelligent[1].

Taking the "National Undergraduate Training Program for Innovation and Entrepreneurship" as its spearhead, University A has actively constructed a national-provincial-university level college student innovation and entrepreneurship talent training system, transforming management to governance and emphasizing the process of harmonious interaction among the relevant elements in project management, with a commitment to the accumulation and transformation of project construction, progressively integrating innovation and entrepreneurship education into the whole process of talent cultivation from shallow to deep. Based on its concept and practice, this paper designs and develops a project management platform for College Students' Innovative Entrepreneurial Training Plan Program[2].

2 PLATFORM DESIGN

2.1 Requirements analysis

The functional requirements of the management system are shown in Table 1 for the users of the project management platform for College Students' Innovative Entrepreneurial Training Plan Program, including students, mentors, review experts, and administrators (college-level administrators and school-level super administrators).

Table 1 Functional requirements of the project management platform [Owner-draw]

Role	Functional requirements
Students	Apply for projects, select mentors, submit project materials, view notifications and activity information, share resource libraries, intelligently recommend and upload related results, etc.
Mentors	View items, modify items, review items, and fill in review comments
Review experts	View projects, review projects, and fill in review comments
Administrators	Publish notification information, assign review experts, manage the project and other user information, intelligent recommendation, and visualize project data

2.2 Design of the system architecture

The functional modules and main management processes of the project management platform constructed in this paper are shown in Figure 1. The core function is to realize the online management of the whole process of the project, as well as to record the process management data and result data at each stage of the project implementation with various offline activities and a shared resource library, so as to provide support for the subsequent continuous funding of the project, the continuous training of students, and the analysis and mining of the process management data[3].

Based on the management function design in Figure 1, the system architecture of the platform is designed as shown in Figure 2. From bottom to top, it is divided into infrastructure, data layer,

service layer, and business application layer. The infrastructure includes the network, server, and storage system. The platform divides the storage system into file storage and database storage to improve data access efficiency, where files are stored on a separate file server. The system server adopts Apache server, and XAMPP software is used to realize the one-key layout of the server, MySQL database, and PHP environment, which speeds up the deployment speed and avoids software incompatibility[4].

The data layer is divided into MySQL database and file database. All user information, project data, and basic configuration in the MySQL database stored procedure management, file name, a storage address, and key ck are stored in the file database[5]. Commonly used configurations of the cache system are presented in Cache.To improve the real-time performance of the data, the data is loaded asynchronously when the data is drawn. With a view to improving the versatility of the module, the function of unstructured data item structure data transformation is provided during design. The unstructured data is uniformly stored in the Json format, and the unstructured data is converted into structured data through the serialization and deserialization of the Json format data and is passed to the data visualization interface of the service layer in an array format.

As the core of the framework, the service layer is responsible for encapsulating various basic components, relying on the data layer downward, and providing access interfaces for the business application layer upward, including statistical analysis, interpolation analysis, stack analysis, etc[6]. The business application layer communicates with the service layer through the HTTP communication protocol. When the client sends an Ajax asynchronous request, the service layer processes the data fed back by the data layer according to the visual container (stacked chart,line chart, pie chart,bar chart, etc.). Then the result is responded to the presentation layer to realize the chart drawing.

The business application layer is the specific presentation of the front-end and back-end business of the platform and provides the front-end interaction interface of the platform[7]. This layer includes a user management module, project management module, resource management module, data visualization module and intelligent recommendation module, etc. The secondary development and expansion of the module can be realized according to subsequent needs, and the business sequence can be flexibly adjusted to meet the school's business needs.
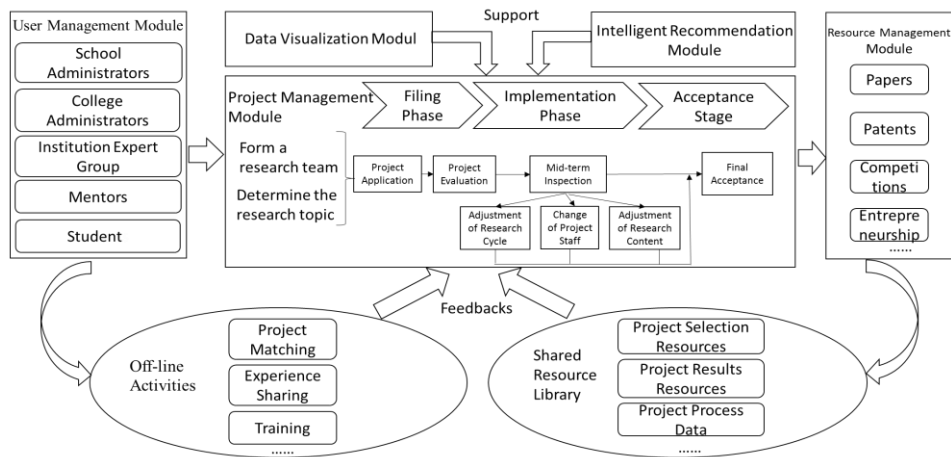
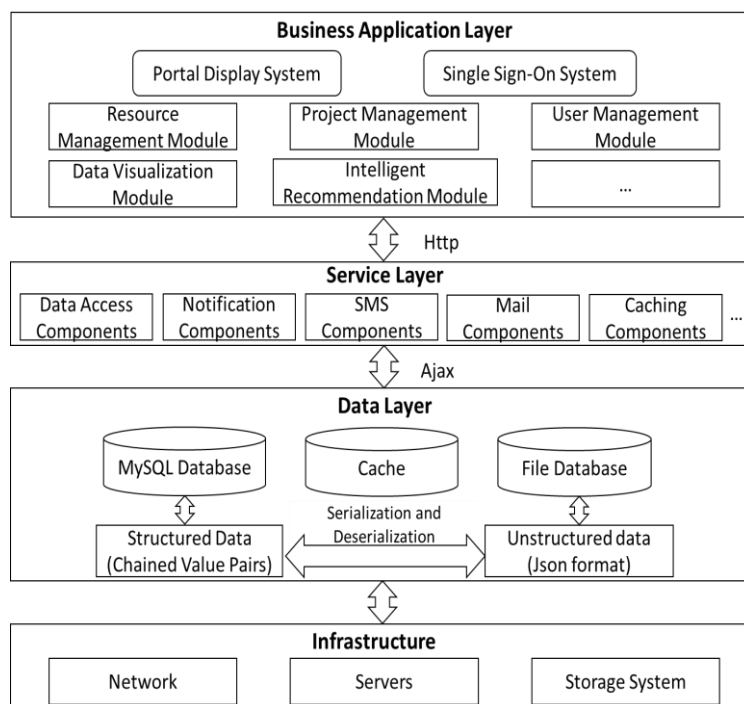**Figure 1** Schematic diagram of the functional modules of the project management platform [Owner-draw]

Figure 2 Design of the system architecture [Owner-draw]

2.3 Platform workflow

The platform can realize the management of the whole process of project research. During the project research process, the project application node and the mid-term inspection node require

the project leader to submit project-related materials and submit them to their mentors for review. Mentors provide project guidance and fill in comments on project application and mid-term results verification. Items that pass the inspection are submitted to the college administrator on the platform. If the check fails, the process terminates. Before the project is submitted by the mentor, the mentor can communicate with the student and send the application back to the student. Students should submit again after revising according to the opinions of their mentors, and this process can be repeated. The final acceptance node requires the project leader to upload project-related technical materials, process documents (Word, PPT, video, etc.), and project results (papers, competitions, patents, entrepreneurial information, etc.). After completing the submission of materials, mentors and review experts will guide and evaluate the project.

The platform shares various project data and resources in the resource management module. Administrators at all levels no longer need to read paper materials and can download the required data through the resource management module, including Excel, Word, compressed files, and other formats. This module also provides students with learning materials on different topics, so that students can quickly master the knowledge of related fields. In addition, at the final acceptance node, the module provides an interface for uploading results to realize the accumulation, inheritance, and transformation of project construction results. The project implementation process is shown in Figure 3.
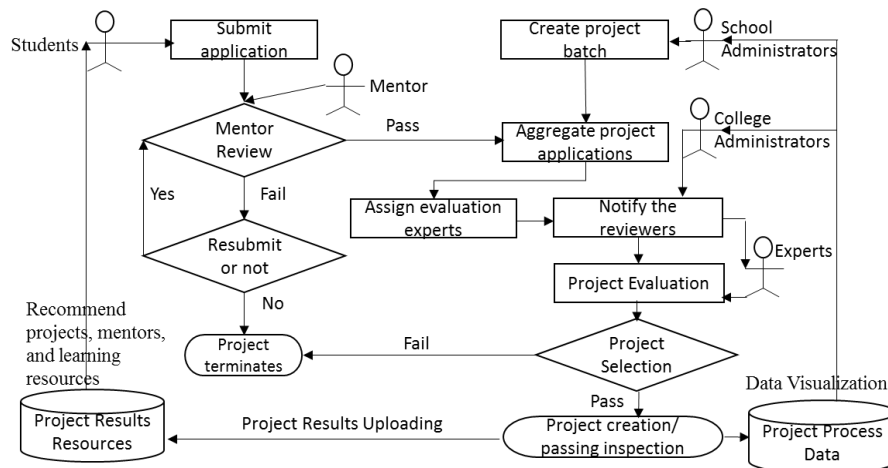

Figure 3 Project implementation process [Owner-draw]

3 JAVA IMPLEMENTATION OF THE PLATFORM

3.1 Development process

The platform follows the basic software development process, and goes through 5 phase, i.e., system analysis, system design, detailed design, program coding, and software testing[8]. In the system analysis phase, the feasibility and requirements of the platform were analyzed in detail by the demand analysts, technicians, students, teachers and administrators at all levels; in the system design and detailed design stages, the framework structure, functional modules, and database of the platform are designed according to demand analysis;in the software coding

phase, the front and back interface design, coding, and platform database construction are carried out simultaneously. The platform is based on the B/S layered architecture, the front-end of the platform adopts the bootstrap framework, the bidirectional data binding is realized based on the MVC model, and the Ajax technology is used to realize the front and back data interaction. The back-end is built on PHP's ThinkPHP framework, and the back-end database uses MySQL[9].

3.2 Function realization

1) User management module

The platform divides user roles into students, mentors, review experts, and administrators (college-level administrators and school-level super administrators), and sets different permissions according to different user roles. Among them, student permissions include viewing notifications, activity information, shared resource library, FAQs, and other column information, as well as intelligent recommendations, submitting project applications, mid-term inspection applications, final acceptance applications, and uploading related results. Mentors can complete the process guidance and evaluation of the project on the platform. Review experts need to review the project at each review node (project review, mid-term inspection, final acceptance, etc.). Administrators include college-level administrators and school-level super administrators. Administrators at the two levels correspond to different management functions in the background, but they can all use the intelligent recommendation module and data visualization module. School-level super administrators can use all the functions of the platform, and can flexibly adjust the business order to meet the school's business needs.

Figure 4 System role interface [Screenshot of the platform]

2) Project management module

The project management module is the core module of the platform, which realizes the online management of the whole process of the project. During the implementation of the College Students' Innovative Entrepreneurial Training Plan Program, three nodes, namely, project declaration, mid-term inspection, and final application are set to control the project implementation process, supervise and evaluate the actual situation of project research and development, analyze differences and problems, and take corrective measures in a timely manner.
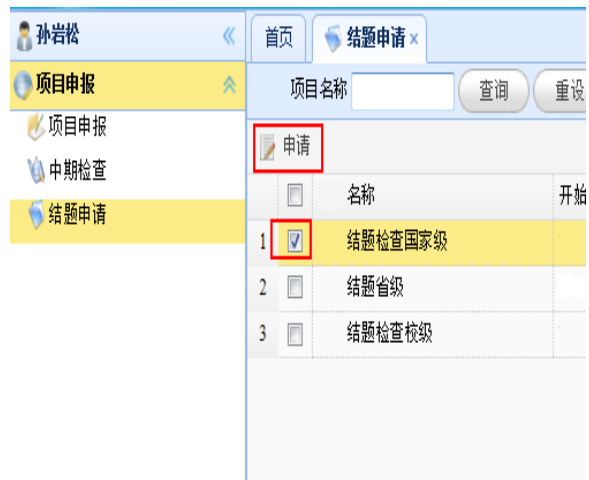
Figure 5 Project management module interface [Screenshot of the platform]

3) Resource management module

The platform shares various project data and resources in the resource management module. Administrators at all levels no longer need to read paper materials and can download the required data through the resource management module, including Excel, Word, compressed files, and other formats. This module also provides students with learning materials on different topics, for the sake of quickly mastering the knowledge of related fields. In addition, at the final acceptance node, the module also provides the function of uploading results to realize the accumulation, inheritance, and transformation of project construction results.
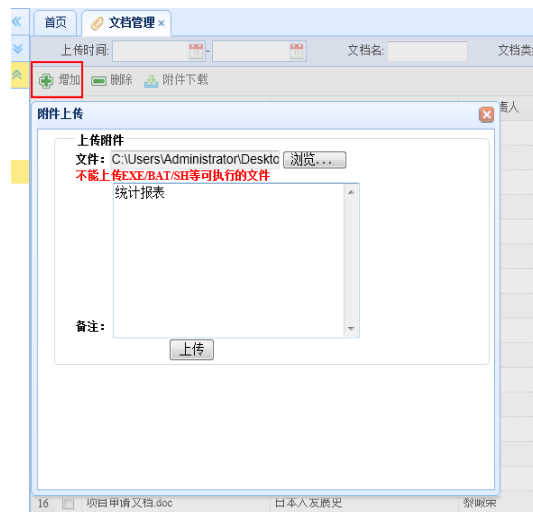

Figure 6 Resource library interface [Screenshot of the platform]

4) Intelligent recommendation module

The intelligent recommendation module is mainly used in the following aspects: mentor recommendation, project recommendation, learning material push, etc. The following takes the mentor recommendation sub-module as an example to introduce the design process of the intelligent recommendation module. The mentor recommendation sub-module is mainly divided into two parts: the preprocessing of Chinese word segmentation and the application of a collaborative filtering algorithm.

a) Chinese word segmentation preprocessing

In the Chinese word segmentation stage, this paper deals with the project title and project introduction. "Jieba" (Chinese for "to stutter") word segmentation is one of the open-source Chinese word segmentation tools with a good word segmentation effect, which is suitable for text analysis. All words that can be formed into words in a sentence can be scanned at a relatively fast speed. Therefore, this paper will use "Jieba" word segmentation for preprocessing and determine the keyword word frequency of the project by means of the TF-IDF algorithm. In this paper, the introductions of 3254 College Students' Innovative Entrepreneurial Training Plan Programs on the platform of University A are subject to word segmentation. Some of the results are shown in the following table. The word segmentation results will be used for the collaborative filtering algorithm to select TOP-N keywords for similarity matching.

Table 2 Keyword statistics of different types of mentor guidance projects [Owner-draw]

Instructor type	Core keywords in the project introduction (top five)	Core keywords in the project introduction (top six to ten)
Off-campus mentor	Provide, implement, platform, develop, design	Technology, system, service, student, company
Primary title mentor	Design, platform, college students, system, intelligence	Culture, application, development, campus, Internet
Intermediate title mentor	Intelligence, platform, application, college students, technology	Mechanism, development, robot, internet, APP
Senior title mentor	System, application, design, mechanism, intelligence	Platform, nano, material, detection, cell

Table 3 Keyword statistics of different types of project names [Owner-draw]

Project type	Core keywords in the project introduction (top five)	Core keywords in the project introduction (top six to ten)
Innovative Training Program	System, design, application, intelligence, mechanism	Analysis, technology, preparation, platform, data
Entrepreneurship Training Program	Platform, company, studio, startup, development	Campus, college students, design, APP, culture
Entrepreneurship Practice Program	Platform, practice, company, startup, studio	Campus, intelligence, culture, service, education

b) Design of collaborative filtering algorithm

Recommendation algorithms can generally be divided into 3 categories: content-based recommendation algorithms, collaborative filtering recommendation algorithms, and hybrid recommendation algorithms. Among them, the collaborative filtering algorithm has a long training process, but after the training is completed, the recommendation process is faster. Comprehensively comparing the advantages and disadvantages of various algorithms, the intelligent recommendation module of this platform is based on the collaborative filtering recommendation algorithm, combined with natural language processing to enhance the semantics of the project subject to achieve intelligent recommendation.

Collaborative filtering algorithms mainly include user-based collaborative filtering algorithms and item-based collaborative filtering algorithms, which are involved in the construction of intelligent recommendation modules on this platform[10]. In the mentor recommendation sub-module, due to the small number of mentors, a user-based collaborative filtering algorithm is used.

The collaborative filtering algorithm is mainly divided into two parts: similarity calculation and recommendation generation. There are various methods in collaborative filtering algorithms to calculate the similarity of items, including cosine similarity and similarity based on Pearson correlation coefficient, etc. When building an intelligent recommendation module, this paper adopts different similarity measurement methods according to different usage scenarios. In the mentor recommendation submodule, the cosine similarity calculation is used.

When calculating the similarity of items, firstly, it is needed to use the result of the "Jieba" word segmentation mentioned above, in combination with the TF-IDF algorithm to determine the keyword word frequency of previous items. TF-IDF is a commonly used weighting technique to assess the importance of a word to a document set or one of the documents in a corpus. The importance of a word increases proportionally with the number of times it appears in a single item introduction but decreases inversely with its frequency in the corpus (participles of all item introductions). Assuming that there are j keywords and k items, the keyword word frequency is calculated as follows:

$$\text{tf}_{i,j} = \frac{n_{i,j}}{\sum_k n_{k,j}} \tag{1}$$

TF refers to the word frequency of the current document, the numerator indicates the number of times the word appears in a document, and the denominator indicates the sum of the occurrences of all keywords in the document.

IDF (Inverse Term Frequency) refers to a measure of the generality of a word, calculated as follows:

$$\text{idf}_i = \log \frac{|D|}{|\{j : t_i \in d_j\}|} \tag{2}$$

In Formula (2), the numerator represents the number of document objects in the document set, and the denominator represents the number of documents containing the current keyword. Taking the logarithm on the basis of this fraction, the IDF value of the current vocabulary is obtained. The weight TF of the keyword is:

$$\text{TF} - \text{IDF}(i, j) = \text{tf}_{i,j} \cdot \text{idf}_i = w_{i,j} \tag{3}$$

Through this algorithm, the importance of keywords in each item can be evaluated. Based on the keyword frequency, a similarity matrix between new items and previous items can be constructed. The similarity of two items can be calculated using the cosine similarity formula for this similarity matrix:

$$\sin(p_m, p_n) = \frac{p_m \cdot p_n}{\|p_m\| \times \|p_n\|} = \frac{\sum_{t=1}^{j} w_{t,m} \cdot w_{t,n}}{\sqrt{\sum_{t=1}^{j} w_{t,m^2}} \sqrt{\sum_{t=1}^{j} w_{t,n^2}}} = w_{(u,v)} \tag{4}$$

After obtaining the similarity between projects, the User-based CF algorithm will recommend N most similar previous projects to the new project, obtain the mentors in these projects, and use a formula to measure the degree of matching between the mentor and the new project to complete the recommendation.

$$p_{(u,i)} = \sum_{v \in s(u,k) \cap N(i)} w_{(u,v)} \tag{5}$$

Among them, S(u,K) contains K previous projects most similar to the theme of the new project u, N(i) is the set of previous projects guided by mentor i, and W(u,v) is the subject similarity between new project u and the previous project v. When recommending a review mentor to a new project, it is only necessary to obtain K previous projects with the highest similarity of the new project according to the above cosine similarity formula, and make a mentor recommendation for the new project through the collaborative filtering algorithm in accordance with the mentor data of the previous project. The recommended process is shown in Figure 7.

After semantic enhancement and collaborative filtering recommendation, the above improved collaborative filtering algorithm can intelligently recommend mentors for newly applied projects. The principles of intelligent recommendation algorithms for other sub-modules are similar.
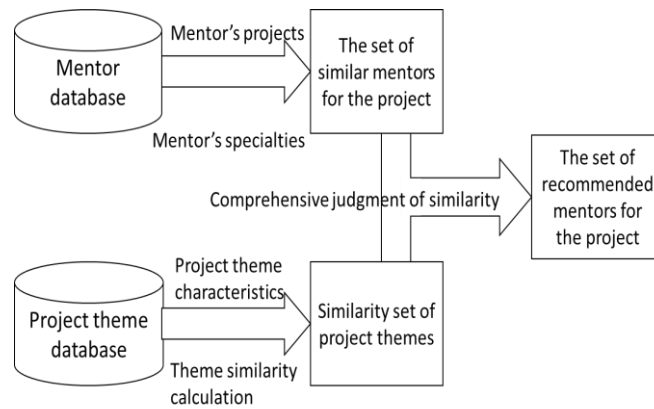
Figure 7 Mentor recommendation sub-module process based on collaborative filtering algorithm
[Owner-draw]

5) Data visualization module

The data visualization module enhances managers' ability to analyze and understand data by providing rich reports and statistical graphics, thereby helping to improve management efficiency. The key to the application of data visualization lies in the later mining, analysis, and processing of data. When constructing the visualization module of this platform, attention should be given to the creation of interactive functions in the visual analysis [12], so that users can quickly obtain effective results of data analysis in a large amount of information, which is convenient for making fast and correct judgments.

At present, the visualization module mainly displays the distribution of the number of projects over the years, the distribution of project types, the distribution of project research fields, the distribution of the colleges to which the projects belong, the distribution of the number of colleges and departments, and the multi-dimensional data processing and analysis of the intersection of colleges and departments. Figure 8 shows the changes in the number of projects approved by University A in the past six years, from which it can be observed that the number of projects has been increasing, and the proportion of projects at all levels tends to be reasonable. Figure 9 shows the distribution statistics of the research fields of the project; Figure 10 shows the distribution statistics of the colleges to which the projects belong; Figure 11 is based on the statistics of the number of projects distributed by the colleges, which displays the data analysis of the students participating in each project distributed by the colleges, suggesting that if all students in the program are from one department, it is a single school, from two schools, it is a cross between two departments, and so on.
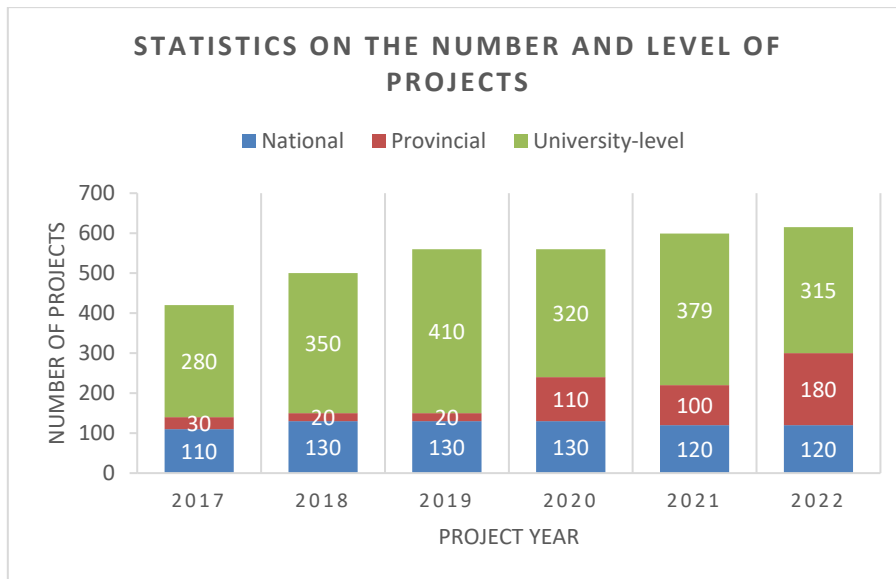
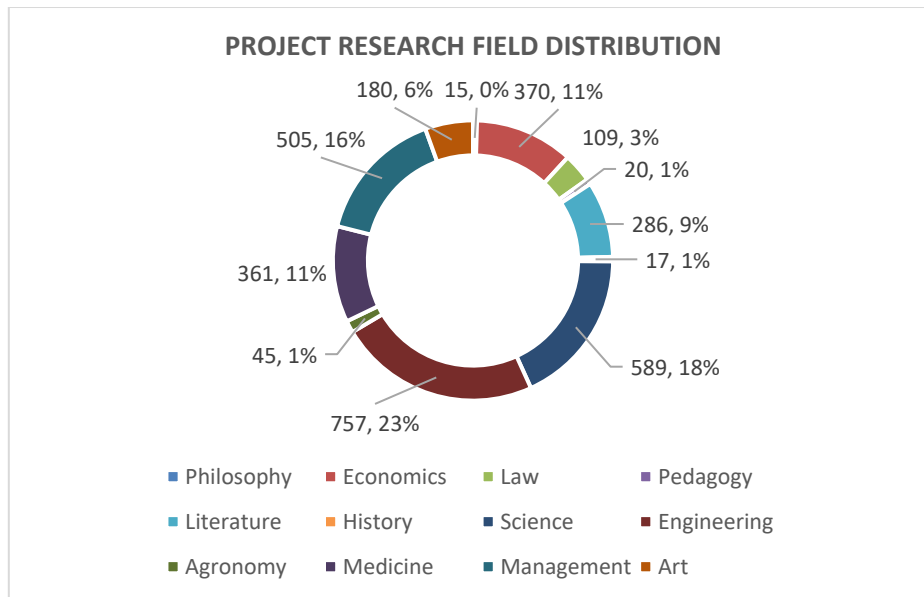**Figure 8** Changes in the number of projects approved from 2017 to 2022 [Platform export]

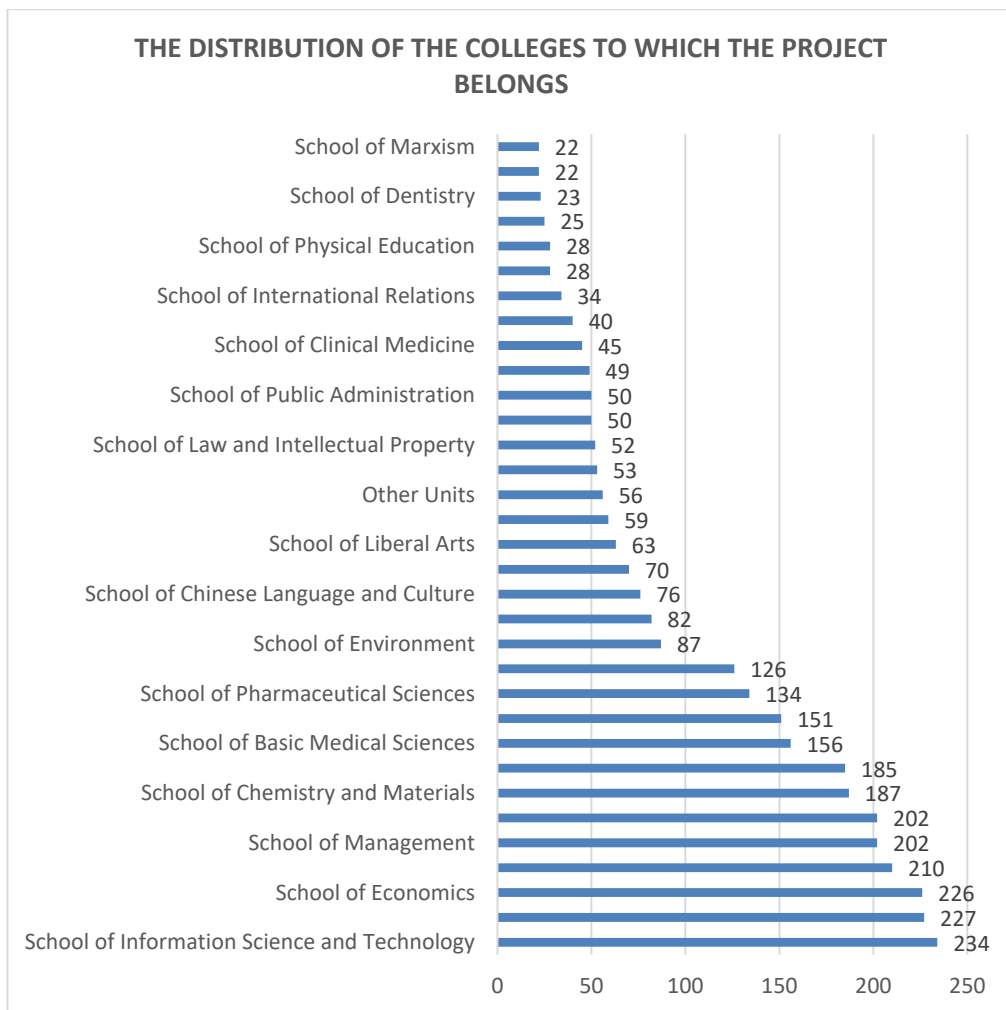**Figure 9** Distribution map of project research areas   [Platform export]

Figure 10 Distribution map of the number of projects in each college [Platform export]
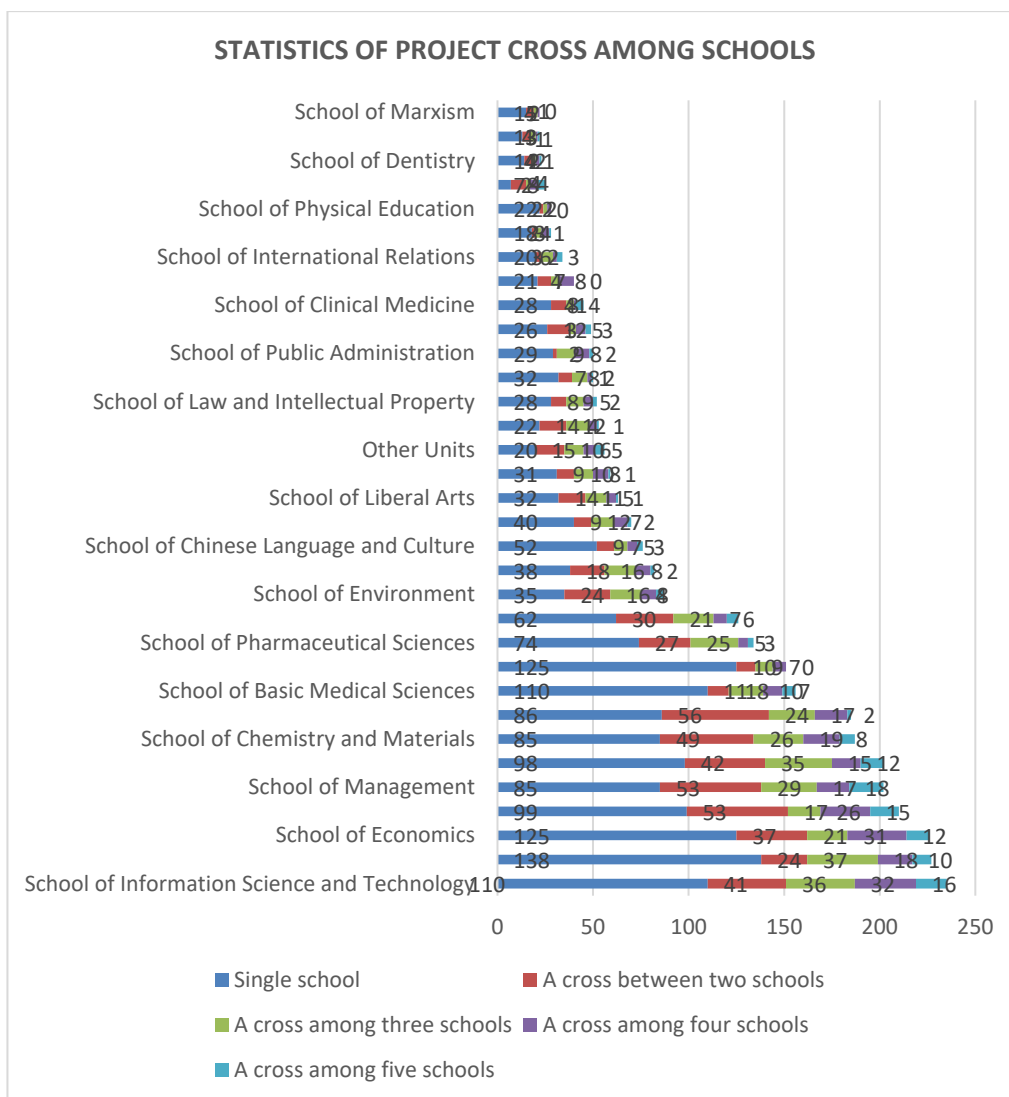
Figure 11 School-department cross char of projects among schools [Platform export]

The data visualization module is currently open to administrators only, assisting them in accurately grasping the development pattern of each index and the training of participating students. For instance, by counting the number of participants in each college's projects, the coverage rate of the College Students' Innovative Entrepreneurial Training Plan Program can be analyzed; by counting the distribution of participating students in each college's projects, the cross-disciplinary situation is analyzed; by counting the number and proportion of national, provincial and university-level projects after the completion of each college's evaluation, the implementation details of the excellent colleges are analyzed to optimize the management mechanism of the university.

4 SYSTEM TEST

After deploying the platform, we organize administrators, teachers, and students to test, and constantly revise and improve the system. Based on the feedback of the test volunteers, the following modifications were made to the platform, including:

1）The exported project table includes all the fields of the platform as optional;

2）The review comments and review scores are set as batch processing;

3）The function of user password reset is improved;

4）The compatibility of the platform on different types of devices and different browsers is enhanced.

After completing the platform test, this paper conducts a survey about platform function satisfaction, interface design, platform effectiveness, convenience, and user satisfaction, the results are shown as follows.

Table 4 Survey results of satisfaction with platform functions and applications [Owner-draw]

Category	Very satisfied	Satisfied	Neutral	Unsatisfied	Very unsatisfied
Portal service	68.7%	21%	8.7%	1.4%	0.2%
Page layout	38.2%	46.5%	12.3%	1.3%	1.7%
Interface design	49.3%	32.8%	14.5%	2.8%	0.6%
User management	55.2%	30.9%	10.1%	3.8%	0
System management	45.9%	28.4%	23.8%	1.9%	0
Data analysis	50.3%	25.1%	16.5%	8.1%	0
Platform convenience	59.3%	21.1%	17.1%	2.5%	0
User satisfaction	54.8%	34.1%	9.4%	1.3%	0.4%

5 CONCLUSION

Boasting an important measure to improve the innovation and entrepreneurship ability of undergraduates, the implementation of the College Students' Innovative Entrepreneurial Training Plan Program serves as an important linkage of the teaching work in colleges and universities. As the scale of College Students' Innovative Entrepreneurial Training Plan Program expands and the resources invested by universities continue to increase, the offline management methods and modes relied on previously have significantly hampered the improvement of project quality and management efficiency. With reference to the concept and practice of the whole process management of the innovation and entrepreneurship training program for college students in University A, this paper designs and builds a project management platform. This platform is based on B/S layered architecture, uses Django as the web framework, Bootstrap as the front-end design style, Echarts as the visual plug-in, MySQL as the database support, and

utilizes the MVC design pattern design to achieve two-way data binding. Through the running practice to prove,this platform realizes the information management of the whole process of the project and the visual display of data and the intelligent recommendation of the project, which improves the efficiency of project management and has certain reference significance for the design of the project management information platform similar to the management workflow.

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