

# The Capstone Project Management System

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## Abstract

All universities provide capstone projects for students before leaving the school to avoid lack of practical experience in future projects in the workplace. The actual capstone project can effectively help computer engineering students in programming practice and project management, and fully investigate the results of students studying in school, which is a comprehensive test for every future graduate who enters the workplace. Graduates of the School of Computer Science at the University of Sydney must participate in practical projects before obtaining a degree and prepared three different types of projects to achieve the ability assessment of students of different study directions. The capstone project is mainly divided into two forms, individual form or group form. In order to make the teachers and students involved in the student team more convenient, the client arranges the project theme, the administrator can add, delete and modify various materials. Therefore, it is the critical reason for developing the project. The project is a web-based management system. Using IDEA to develop the project, Java as the programming language, and use NoSQL-based Firebase as the database technology. The web server base on the Tomcat, the view model can combine the Java Server Pages (JSP), and the front-end framework could be built by Spring Boot, which is the latest development structure to develop Java Web applications. In addition, the waterfall model method is the project process infrastructures to develop the capstone project management system, which is convenient to operate and understand, as well as provides a clear and reliable architectural support for projects in the development process. Our team eventually deliver the project in the form of a web application, which will run and operate on both PC and mobile devices. Meanwhile, the project will be able to achieve excellent capstone project management to improve the client's work and ensure students complete their graduation design.

## Keywords

Capstone Projects; Project Management.

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## 1. Introduction

Owing to previous education concepts, most of the universities preferred to provide theory courses than practical ones, which result in numerous companies' discontent or embarrassment for graduates (Tuzun et al., 2018). In order to improve this situation, almost all universities provide students with capstone projects before leaving school to avoid having no actual project experience. The graduates of the School of Computer Science at the University of Sydney must participate in a practical project before earning a degree. The capstone projects can be divided into two forms, individual or group. For Group projects, students who enroll in this course will form groups with 4-5 people in the one-semester period. Moreover, for individual projects, students need to complete an apex project independently in two semesters. In addition, throughout the project, students should contact the client and meet with the administrator (course tutor) to review the progress.

The information technology school, however, does not have an independent capstone project management system, and administrators can only manually complete all project management processes on Canvas. Therefore, the purpose of this project is to provide a convenient web platform for the capstone project management system for different users (including customers, students, and project administrators) to reduce the workload of the college administrators and improve processing efficiency. At the same time, provide a feedback platform for the project to help users communicate with tutor in time and get evaluation. In particular, customers directly participate in the process and communicate with the project team in a timely manner to amplify the functional requirements of the client. In addition, for students, the system can simplify the selection process of capstone projects and optimize team formation methods. Team up with students of the project type to complete the graduation project.

Therefore, in order to better realize the capstone project management system of the University of Sydney, we divide the entire management system into three ports to meet the needs of different user groups. For clients, their main purpose through this platform is to more conveniently manage and supervise the project progress and implementation of different capstone groups. According to different project types, to provide reliable and efficient guidance for different project teams, such as data science is more inclined to analyze big data and machine learning; and software development is more focused on the realization of various functions and data security; Finally, the information system for project developers, more need to invest more energy in information management and analysis processing. In general, by using this management platform, students can help them choose the capstone project that suits them more conveniently and in a targeted manner at the initial stage of project selection and can view detailed information about different types of projects. In addition, they can also communicate with clients and tutors through the system at any time and get the latest feedback on time. Moreover, the client can use this system to give the final results of different projects, or it can track all the progress of the project in real-time and guide students to improve some functions at any time. As the administrator of the entire system, all background data can be modified and updated. In order to coordinate the work of clients, the administrator can adjust and change personal information and group information. And you can set the presentation time for each project at the end of the semester.

The capstone project management system use case diagram shows the system usage relationships and permissions between three different types of users. First of all, the main purpose of students to use the system is to query the capstone project, upload personal information, obtain the final score, and select the preference project. Secondly, the main function of the client is to provide a capstone project table, view the student's personal CV, manage student projects, and provide final feedback. The student's personal information and preference items are also covered by the administrator's authority. Finally, the administrator mainly performs the functions of the managed system background, including changing student information, capstone project options, managing the system, uploading student information, setting presentation slots, and managing selected projects.

This capstone project management system integrates the functions of publishing, tracking, scoring, and managing student and project information for all projects, and better adapt to the requirements of schools and clients for the capstone project system. Provide students and tutors with a convenient platform for communication and feedback.

The capstone management system is based on the MVC framework of Springboot. The whole system is mainly composed of three major modules, controller, service and model. Among them, the controller is mainly responsible for the requests sent by the front-end user through the http protocol, and makes instructions when the command is obtained to pass the task to the service layer. Secondly, the service layer performs preprocessing after receiving the instructions returned by the front end, and then decides which commands to call to implement the instructions based on user requests. It can directly connect to the model for command processing, or interact with the back-end database through dao package to store or extract data information. In the entire service layer, the Springboot

architecture uses the Maven repository for class extension. The above is the basic architecture of the management system.

In the capstone project management system, the three major users have different positions on the use of the system. Among them, student and client are the two main platform users, and most of the functions between them are consistent, but the permissions of the student port are much smaller than the permissions of the client. Be processed. In addition, the client can be adjusted according to the preference list of different students and groups. For the student side, they can visit three pages, preference project, marks and schedule tables. These pages mainly provide the display of projects, final scores and daily tasks. Students do not have the right to modify and are limited to browsing. But for the project list and presentation slot, students are free to choose their more preferred capstone project and presentation time at the end of the period. The functions possessed by the client are relatively simple and concise. The system mainly provides a list of capstone projects. Clients only need to analyze the data of previous projects to publish the type and number of capstone projects. The project and presentation time selected by the students help the client to arrange the end of the period. At the same time, different capstones can also be fed back to each group. Finally, admin is the administrator with the maximum authority of this system, can obtain the information of the entire system, and provide background service guarantee for students and clients. And at the end of the semester, the capstone project of this semester can be completely analyzed, and feedback can be provided for future reference. Therefore, admin manages the entire capstone project system to ensure the stable and efficient operation of the system.

The capstone management system consists of multiple packages, including Config, Controller, Dao, Entity, Service, and two interface classes, LoginInterceptor and WebMainApplications. The Config package is mainly used to call the front-end UI files and control all UI pages and pass parameters. Secondly, the Controller package file is the control center of the entire system. The Controller executes user instructions and calls functions to pass parameters and instructions. It is the core component of the management system. It includes dashboard control, login control, marking control, group control, preference control, profile control, project control, semester control, and web control. The package file of the control center basically covers all functions and main code files and realizes the framework structure of Control in the MVC architecture. Thirdly, the Service package integrates all the execution commands in the entire architecture and calls the entity class through the transfer of parameters. Service package mainly includes group service, login service, marking service, profile service, project service, semester service, and student preference service. Therefore, the Service package is also an important part of the MVC architecture, which mainly realizes the function of the collection and transfer function of the Model. Fourth, the Entity package is the most basic and crucial part of building the entire management system. The Entity package covers client, student, group, project, student preference, login, and semester class. In the framework of Spring boot, the entity class defines the main information of users, clients, and administrators in the entire system, such as name, ID, age, and contact information. Therefore, the entity class implements the most basic class in the entire architecture and makes an extremely important contribution to the construction of the back-end database. The Entity package shares all user and clients' personal information with the back-end database, as well as the information of the capstone project, and covers a series of private information such as display time, user feedback, and job scores. Finally, the Dao package is a back-end data package that stores all information related to the project. It calls all the subordinate clauses in the Entity class, such as calling the Group class to create a group linked list to store personal information. Last but not least, the two interface classes included in the project, login interceptor, and web main application are the basic functional classes to implement authentication and start project procedures when users and clients log in respectively.

## 2. Related Literature

### 2.1 Literature Review

#### 2.1.1 The importance of the Capstone Project

At present, most enterprises tend to choose employees with practical experience, rather than employees with high theoretical education. Many studies focus on the gap between traditional theoretical education and employers' expectations. According to Brandon et al. (2002), it graduates must have four abilities, including (1) personal abilities, such as problem-solving, critical thinking and other skills. (2) Communication and collaboration skills. (3) Technical ability and development ability. (4) Business skills.

According to Aasheim et al. (2009) work experience has a high correlation with academic performance. To eliminate or narrow the gap between industry needs and concerns of colleges and universities, the key is to turn pure theory courses into more practical courses. Practice project is an effective way for students to consolidate their theoretical knowledge and deepen their understanding. It is an important link in training high-quality engineering and technical talents with innovative consciousness, an important platform for integrating theory with practice, and an important platform for students to master scientific methods and improve their practical ability.

Professionals in the Department of computer science at the University of Birkent (2018) studied the Harvey College Summer School, which provides students with a series of intensive practical courses to train high skilled students for enterprises. Therefore, according to the survey of participants, all students believe that practical courses are beneficial for them to graduate or choose to continue their studies. More specifically, the summer school curriculum is considered a complement to theoretical education, which provides knowledge consolidation and new skills, and will contribute to future career.

In addition to intensive courses, many universities also offer capstone courses to enhance the practical experience of students and even teachers. Bradley University (2013) provides professional master teachers with heavy first-class tasks. The purpose of the reflection project is to improve their professional skills, academic knowledge and attitude towards the project. After completion, they need to comprehensively consider their own experience and combine with the actual situation in order to promote their teaching plans and methods to a more practical and effective method for other schools to refer to and learn from.

#### 2.1.2 The background of the project management system

With the development of economy and technology, the workload and processing complexity are increasing at an alarming rate. Therefore, different types of project management systems have been implemented for different application scenarios. However, most existing project management systems are only applicable to their own companies or organizations (McCollum, 2015). The biggest advantage of the project management system is to optimize the project management process and improve the project management efficiency (Arain, 2009). Specifically, the first advantage is to ensure the consistency of project planning and implementation, which means that users can identify the project schedule in time to match the plan. The other is that the data analysis page allows users to control the entire project in one page. In addition, project management tools can effectively reduce errors and time costs caused by manual operations. One of the most popular project management tools is the Microsoft project, which was originally designed for construction projects and is now available for many large projects (McCollum, 2015).

Oracle's Primavera P6 project portfolio management is currently considered to be the most standard and effective project management software, with obvious advantages in managing large-scale, high complexity and multiple projects. Since large amounts of data processing require complex and flexible organizational management tools, Oracle p6-ppm provides multiple management methods for the screening and classification of enterprise organizations, projects, and resources (Oracle, 2020).

### 2.1.3 The analysis of existing similar system

As mentioned above, various project management systems have been implemented in enterprises or large-scale projects. However, our project focuses on the capstone project management of the School of Computer Science at the University of Sydney. At present, some colleges and universities have introduced similar systems, such as Canvas, to evaluate students and faculty and staff to improve the effectiveness of the capstone project. Review and compare similar systems to identify and differentiate our projects.

Monash University (2002) proposed a Web-based tool: WIER (Web Industry Experience Resource) for high school students. This tool is multifaceted because it provides a platform for viewing past projects, managing existing projects, collecting the latest resources, backups, and other content. In addition, WIER can also help different types of users (ie students, clients, supervisors and coordinators). An evaluation conducted in 2001 showed that students generally considered this to be a useful resource. Students at Alhosn University have designed a tool to manage the different stages and tasks of the project (2011), while allowing teachers to track progress. Students can view and select the purpose of the project, wait for teacher approval and feedback, and set tasks and deadlines. In addition, the system supports communication between teachers and students.

According to Olat et al. (2014), University of Pennsylvania students can submit projects after completion, which may be useful for future students because they can avoid publishing projects, but this allows them to learn from previous experience. The system does not provide a way for students and teachers to communicate, nor does it provide a function to upload different stages in the development process. In addition, Al-Dallal (2018) introduced a similar system called SPMS (Advanced Project Management System). Teachers can upload the purpose of the project on this platform and allow students to register from the suggested project list and choose their own preferences to implement their ideas and complete the project's practice. With the approval of the teacher, students can submit mid-term reports and final reports, and teachers can view the submitted reports, post comments and score.

## 2.2 Conclusion

More and more companies realize that practical experience is more important than theoretical education in selecting employees. Therefore, universities must set up basic projects for senior students and provide opportunities to increase project and collaboration experience. In order to better manage these projects, improve efficiency and reduce human errors, a special peak project management system must be designed. In addition, on the basis of comparing the existing similar systems, our project will focus on increasing the participation of clients and students and reducing the pressure of managers.

## 3. Research/Project Problems

### 3.1 Research/Project Aims & Objectives

The project aims to design a fully functional and interactive friendly capstone management system website for the University of Chengdu University of Technology School of Computer Science. Specifically, customers can use the system to publish project goals and approve appropriate students or groups. Students can view and submit all the processes of the entire project. In addition, administrators can automatically schedule students, analyze data and manage the entire schedule. In summary, the goal of the Capstone project management system is to provide tools for different users to simplify processes and increase efficiency and participation.

### 3.2 Research/Project Questions

In the formal development project development phase, the following potential issues are fully considered.

### 3.2.1 The website access

Since the capstone management system is developed based on the web application, the network access technology issue is indeed a key issue. Due to different users, there are different network conditions. In order to ensure that users can have an efficient user experience and access fluency when visiting the website, we have fully considered different realities to solve or alleviate the network delay problem. There are two options below. Option A: only local network access. Although the access corresponding speed for operation and execution will be improved, it definitely relies on the place which could be limited. Option B: access by using the Cloud web server. It is convenient to access the website and save the user's information effectiveness. However, the option could meet network obstacles, such as operation with low speed or even disconnected.

### 3.2.2 Project allocation

Project allocation is the core function of capstone management projects. Make sure that different students can group with classmates of the same project type after choosing the preferred project. Therefore, in order to ensure the high efficiency and low error rate of the packet, different schemes have been proposed. Option A: random allocation, which is more friendly for students who meet network latency. But, allocation the operation error for same name or birthday student may occur. Option B: allocation based on applying time. The system will distinguish the submit time for every student, and according to the previous time, separate the student with same category project to a group, which can minimize the potential error, fare for all students. But it will need the higher requirements on the web server and database.

### 3.2.3 Marking standard

Based on the meeting communication with the client, the scoring standard for capstone management projects is different from other professional scoring. The School of Computing Science requires that the final score of the capstone project is based on the combination of the project and the team. For example, the project team's score is based on each progress report, which includes evaluation and final project presentation. The individual score is the weekly individual report score plus the project team score. So different students will have different final scores. Therefore, there are two alternative options for the development of project. Option A: the final mark will be graded by clients, which could more match the clients need. But it will be lack of unity and fairness. Option B: unified formulation for all student based on the proportion of different assignments. this option is more convenient to manage

### 3.2.4 Way to Login

There are different operation methods for user login access. First, users with different access rights have different login interfaces. For example, students are the most common login interface, if students' accounts and passwords are required. The client is also the same login method. However, the administrator needs to have a different port to log in to the management system and can grant or cancel the login permissions of the student and client accounts. Option A: verify by university email, which is convenient to developing and minimize the size of the system to increase access speed, however, is may more complex for system because it requires accept third-party access agreement. Option B: login with student Unikey. It is easy to log in without verification by which need the dataset of student Unikey and password

## 3.3 Research/Project Scope

### 3.3.1 Scope Includes:

Design a web-based application with a user-friendly interface functions shown below.

### 3.3.2 Login:

Users (clients/students/administrators) log in based on their roles, then different entry interface.

### 3.3.3 Browse:

Students can look through the list of projects post by clients and other information. Clients can view the list of students and their CVs and give the project feedback timely. Administrators can manage the entire system to guarantee the personal information security and client final marks security.

### 3.3.4 Analyze data:

The types of projects and projects allocated to clients.

Upload, edit, and delete:

clients can post the requirements of project, administrators can conduct essential manage functions whatever groups or projects and create mark formulation. Students can submit or modify the process documents of the project.

### 3.3.5 Automatic allocation:

For forming groups or allocating projects.

### 3.3.6 Scope excludes:

User guideline, System adjustment after delivery, Routine management after implementation, Roll out and promotion activities.

## 3.4 Methods

The Capstone project management team will use the waterfall model enterprise and project development methods to develop the capstone project management system. Waterfall is a cascaded SDLC model, where the development process covers a complete pipeline process, step by step analysis, prediction, implementation, testing, implementation and support. The SDLC model covers a complete step-by-step implementation of each stage. The process is strictly recorded and predefined, and has the functions expected at each stage of the software development lifecycle model. Moreover, it provides a solid foundation for the smooth development of the project.

Waterfall model has a lot of benefits. First of all, it is easier for everyone to use and understand, and the management of software development is also very simple, because the development is carried out in stages. In addition, tasks can be easily classified and prioritized, and key points in the development cycle can be identified. Generally speaking, the waterfall model approach has six stages, including: (1) Planning and Requirement Analysis, (2) Project Architecture & System Design, (3) Development & Implementation, (4) Testing, (5) Deployment and Maintenance.

In terms of this capstone project management system, the client has already provided us with clear and specific requirements without ambiguity. These requirements are accurately recorded and there are no ambiguous requirements. In addition, the development cycle of the project is not very long, it is a relatively short project. Therefore, our team found that waterfall model method is very suitable for the development of this project. It can help us manage the progress of project and have a corresponding delivery in each development stage. This can make sure our progress of project development on time as possible as we can.

The grouping algorithm is the most important core algorithm in our project. It first judges the submission time of all students' preference items, and then traverses all students according to the submission time. For example, first determine the three preference items of the first student. If the first item is not full, then add the student to the first item. If it is full, continue to traverse the second preference item until the last item is traversed. If all the items are full, it will return to the first step and let the students reselect the three preference items to traverse again. Finally, repeat the above process until the list submitted by all students is completed. Then the students are grouped according to different projects, and then the results are returned to the client and admin.

## 3.5 Data Collection

The main method of collecting project data is to obtain data and requirements through online interviews with clients. Interview is a simple, convenient and feasible way to obtain information

efficiently. Through the in-depth conversation guided by the client, you can quickly obtain reliable and useful data. Not only does the personal interview save time, it also relaxes the emotions of the participants. After careful consideration, answering questions and inspiring each other are conducive to the in-depth development of questions. For example, regularly meet with customers to understand and discuss their requirements, so as to obtain more accurate demand data, because accurate data is more conducive to the subsequent development of the project. More importantly, we use the CUSP course information system of the University of Sydney to provide us with detailed information on all required courses, including the project name, type, clients and introduction. Because our project is software development, we will focus more on implementing more functions. Therefore, the types of data collected are more uniform and the same.

### **3.6 Data Analysis**

During the project development, we often have brainstorming sessions meeting for data analysis. Because the Brainstorming is a group innovation technology, which is usually used in the process of gathering requirements. In the process of brainstorming, every new idea will arouse others' Association. A series of new ideas have emerged. These new ideas have a chain reaction and formed a new thinking pile, which provides more possibilities for creative problem solving and gives full play to the ability of creative thinking.

In addition, the FURPS+ model is a common method to analyze requirements. The project system will use the FURPS+ model to describe and explain all requirements. The acronym FURPS is used to describe the main categories and subcategories of elements, including functionality, availability, reliability, performance, and supportability.

It is sufficient to use the FURPS+ model as a list of the scope of requirements, so as to avoid missing some important aspects of the project management system. Since the initial purpose of the project is to achieve the peak management function, we divide the project into three different ports to complete development at the same time, and each port develops different project functions according to different target groups. First, the client portal must be able to post, update, and view all projects submitted by students, and provide project feedback to each group at the end of the semester. Second, students need to submit, view, and modify information about project team members and the location of the preferred presentation. In addition, students can calculate the final grade at the end of the semester according to the formula given by the client. Finally, for administrators, the functions they need are the most complicated, because administrators can get the background of the entire operating system. Administrators can implement many functions, such as creating vertex projects; viewing, accepting or rejecting submitted projects; uploading student personal information; creating and modifying groups of all projects; automatically grouping students of the same project; can create and modify student projects Presentation location. The most important task of the administrator is to analyze the selection of each project type and provide feedback to clients.

### **3.7 Deployment**

The final product is a web-based application deployed on a Windows or Mac system. Two types of deployment will be provided on the client's infrastructure. Our program application can be compatible with different browser platforms and development platforms to ensure later maintenance. Generally, web-based applications should be used on local servers or cloud servers. Here is very specific details to show how to deploy this web-based applications on these two types of servers.

Once the software passes through all phases, without any problems, it will go through a maintenance process, in which it will be maintained and upgraded to adapt to changes. For the maintenance phase of capstone project management system, the client will maintain the system and repair the vulnerabilities in the system by themselves.

## 4. Conclusion

Our project has the great practical significance. Because our project provides a functional and convenient project management system for different users (including clients, students and project administrators), in order to reduce the workload of administrators, improve work efficiency, and provide a platform for clients to directly participate in the process to improve their satisfaction. This management platform greatly helps administrators to manage all students and clients involved in the project.

Specifically, the management system greatly facilitates clients and students to use it to manage their own projects. First of all, the project achieved that clients release projects to the system, and students choose projects according to their own preferences. And the administrators can use the system to grade the students'scores in each stage, and the client can feedback the evaluation of the project to the students after completing the project. It solves the management difficulty caused by the increase of the number of students who choose the project. Because the school of information technology does not have an independent capstone project management system, administrators may manually complete all management processes on the Canvas. However, the number of students choosing projects is increasing, and the data information processing of students choosing projects is becoming more and more heavy. Therefore, in order to reduce the processing workload of relevant data and information, and enable every student in school to better select their prefer projects, for the matter of selecting projects, the system will carry out relevant design for the three directions of the students' choosing projects, the client's project publication and the administrator's management of projects, and can complete students' choosing projects online, the query of selected projects, personal data and information modification, client can publish project information and other functions.

Now the school of information technology must establish an independent student selection project system, which is very important for the project information management of the school of information technology. Therefore, the student online project selection system can let the students know all the projects that the school opens in this semester more comprehensively, and also facilitate the administrator's management of the relevant information of the students. Compared with the traditional manual management, it has many advantages, such as, high efficiency, good confidentiality, long-term and undamaged storage of a large number of data files, which can be better Searching, updating and maintaining can reduce a large number of relevant staff and standardize the management of this information. Therefore, it is very important and practical significance for the school of information technology to develop an independent student selection project system.

In the design of student online project selection system, the computer information technology is used to support the school administrators to manage the project, improve the modern level of the school of information technology in the management of student selection project, optimize the allocation of the comprehensive information resources of the students, provide a full range of information services for the school of information technology, and provide a great support for the school of information technology in the work of student selection project.

Our project management system can basically achieve the design and implementation of the student selection project system through the actual needs, and reasonably select the operating system, data structure, database and development environment to establish a correct design idea and improve the system structure, which can play the advantages of the system. In general, our project management system has the following advantages:

### (1) Practicability:

Aiming at the needs of students, clients and administrators, and based on the principle of convenient management, a relatively complete online project selection system is designed through needs analysis, which is convenient for administrators to manage relevant data information as much as possible. Students and clients can choose projects or release projects directly through friendly interface without training and teaching. This makes the system have real practicability.

(2) Convenience:

Students and clients can choose projects or release projects at any time, which greatly facilitates the use of students and clients.

(3) Sharing:

The design of our project selection system realizes the sharing of the system. As long as the administrator of the online school in the school can use the system, it brings convenience to the relevant work of the school administrator.

(4) Reliability:

Through advanced network design and selection of software and hardware, the project management system is a highly reliable system.

(5) Maintainability:

During the design of our project management system, the system has been required to be convenient and easy to maintain, including hardware maintenance and software maintenance.

However, there are still some deficiencies in our system. At present, the system is planned to run on the school server, but in fact, the number of students and information data is very large, which has certain requirements on the performance of the school server. This may greatly affect the fluency of the system. This will be explained in detail in the next part.

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