Research Article

Design E-Consulting System Using the Waterfall Model

Fajar Ciputra Daeng Bani[1], Bayu Prabowo Sutjiatmo[2]

[1,2]*Department of International Trade in the ASEAN Region and RRT, Politeknik APP Jakarta, Timbul Street No 32, South Jakarta, Indonesia*

A B T R A C T

In the era of rapid development in information technology, the integration of technology into the education process becomes crucial for informed decision-making. This case study addresses a serious issue related to suboptimal reporting in academic guidance activities within higher education institutions, where the development of academic potential occurs through academic guidance. Academic guidance provides continuous support and advice to students by academic supervisors, with the aim of ensuring a smooth academic journey. However, the lack of optimal reporting impedes effective decision-making. Recognizing the strategic role of technology in education, this research proposes the implementation of an e-consulting system using the waterfall model. The main objective is to provide academic supervisors with concrete reports on lecturer workload, empowering them to make informed decisions. Simultaneously, students receive evidence-based academic guidance reports, crucial for meeting final project requirements. This case study illustrates how the waterfall model can be systematically used to design and implement the e-consulting system, meeting the specific academic needs and preferences of users in higher education institutions under the Ministry of Industry, Republic of Indonesia. This research provides insights into the importance of leveraging technology to enhance academic guidance, contributing to the overall efficiency and effectiveness of the education process. The findings aim to inform educational policymakers, educational institutions, and stakeholders about the potential benefits of integrating technology-based solutions to address challenges in academic guidance within the Indonesian higher education system.

INTRODUCTION

Higher education, as an institution engaged in educational services, is currently heavily reliant on information and communication technology (ICT). The utilization of information technology can improve the quality of education to be efficient and allow for quality control of learning that is relevant, accessible, timely and sustainable(Oktarina & Darma, 2023). One significant innovation is the E-Consulting system, which enables the academic guidance process to take place online, providing greater flexibility in terms of timing and accessibility for both students and academic supervisors.

In the academic guidance process, students are required to carry out academic guidance with an academic supervisor who has been determined by the academic section. Guidance for students is needed to help students develop their welfare, especially on essential self and social factors with sub-factors of spirituality, self-care and love (Wahyuni et al., 2018). The process of academic guidance is carried out face-to-face between students and supervisors who often encounter many obstacles in the process, for example, lecturers are required to travel out of town or have other activities outside the campus, forcing students to postpone the guidance process (Rini & Purnama, 2019). To produce competent students, qualified facilities and infrastructure are needed so that students can be productive and creative in the learning process (Kurniawan et al., 2021). Besides the existence of computer technology, to support academic activities in increasing efficiency and speed requires a lot of human resources who are reliable and able to operate computers properly(Putriningsih et al., 2022). An information system needs to be created so that lecturers and students are more intensive in conducting formal and non-formal guidance that is more effective and flexible(Hikmatyar & Sumaryana, 2019).

However, can the Waterfall model be effectively applied in designing the E-Consulting system to support online academic guidance. The Waterfall model has long been recognized in the world of software development for its well-organized stage structure, starting from planning, analysis, design, implementation, testing, to maintenance (Wahid, 2020). The success of implementing the E-Consulting system depends significantly on a well-designed system, considering the unique needs of online academic guidance. Therefore, this research aims to bridge the knowledge gap by detailing and examining the process of designing the E-Consulting system using the Waterfall model.

This in-depth research will involve user requirement analysis, system structure design, technical solution implementation, and system testing. Designing using the Waterfall model is expected to provide clarity and stability in each development stage, which is crucial in ensuring the system meets user expectations and complies with high-security standards. By exploring and detailing the application of the Waterfall model in the design of the E-Consulting system, this research is expected to make a significant contribution to practical and theoretical understanding related to the implementation of technology in the context of academic guidance in the digital environment. The findings of this research are expected to provide new insights into the development of similar systems and enhance the quality of education in this digital era.

METHOD

Research Stages

Researchers need to create interactive flows using flowchart applications to provide various stages to management (Yeke, 2023). The flowchart will be the starting point for understanding the overall trend as a discussion platform for general introduction then the collected data will be summarized into a holistic flowchart (Wang et al., 2020).The following is a flowchart of the research flow (Figure 1.).

Identification Problems

Stages to facilitate the flow of thought of researchers to identify problems using fishbone analysis which is one of the methods in improving quality. The use of Fishbone analysis can be used as a good corrective action proposal in a problem solving based on cause and effect(Lenawati et al., 2023). Then the researchers collect primary data according to the process of need for academic guidance. Primary data refers to the type of data collected directly from the original source for research or analysis purposes. Primary data is obtained through research conducted directly by researchers or through instruments specifically

designed to collect data. The model used in designing the e-consulting system, namely the waterfall model, is a sequential development process that flows like a waterfall through several stages including.
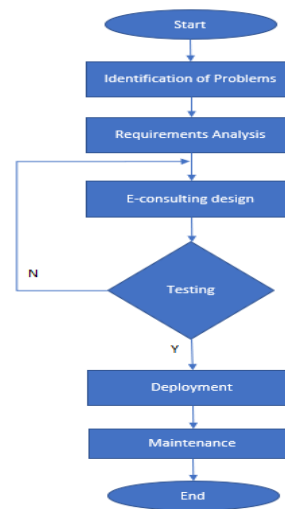

Fig. 1. Research Flow

Requirement Analysis

The process of identifying and understanding the needs, problems or challenges faced by individuals, groups or organizations. The aim is to gather relevant and accurate information about what interested parties need or want in a given context. The data collected will be mapped with examples of the number of students distributed to each supervisor, the requirements for the number of guidance students and calculations at the end of each semester. By collecting some information about user needs that is useful for knowing and helping design the academic guidance application that will be made (Ridwan et al., 2021).This information can be in the form of functional requirements in applications, problems and solutions that can be achieved from designing e-consulting systems using the waterfall model.

E-consulting Design

This stage is carried out by determining the required data structure, software architecture, and user interface design that is adapted to the concept at the needs analysis stage which is then made a design by utilizing hardware and software on a computer(Nurseptaji, 2021). Design phase is depended on the types of products that will be need to develop a system, need to create use case diagram, sequence diagram for database and wireframes or storyboard for the system interfaces and interactivity(Nor et al., 2023).

Testing

Testing begins by identifying and understanding the specified user requirements for the academic guidance

application. Each user requirement is tested to ensure that each unit of the behavioral code meets the developer's expectations and fulfills the established business needs. System testing involves testing various components of the academic guidance application, including the user interface, functionality, and overall system integration. Testing is conducted to ensure that the system operates as intended and aligns with the specifications, design, and coding that have been implemented. System testing is a critical element of software quality assurance and represents the main study of specifications, design and coding (Chandra Ramdhani, et al., 2018). Stages of testing by testing only one code at a time(Nugraha et al., 2019).

Testing is performed by testing one code at a time, ensuring that each function operates correctly and meets the requirements. Maintaining a clear and consistent naming convention for test units. This facilitates the efficient identification and maintenance of tests. If there is a change in the code within a module, ensure that there is a corresponding Unit Test Case for that module. This mechanism ensures that every change is thoroughly tested to avoid bugs or potential issues. If bugs are identified during unit testing, they must be fixed before proceeding to the next stage. Ensuring that the system is free of errors that could affect functionality and performance. Exploratory testing can find fault with everything which is a helpful approach to gain an understanding of how something can operate(Mohialden et al., 2022). This approach helps gain a deeper understanding of how the system can operate and explore all possible errors.

Deployment

Deployment is a stage that carries out the process of deploying a software system or application to the desired or expected environment. It involves the steps to effectively install, configure and run the system so that it is ready for use by the user. The deployment stage was made to unify all program designs into an integrated whole and to re-verify the complete program so that it can be adapted to user needs and meet quality requirements. stages that are ready to be installed and used by users(Ilham et al., 2021).

This stage can change the concept and architectural design in the application of academic guidance into a structured program, then testing the program that has been made so that the program is made in accordance with the concept that has been set at the beginning of the process. Solution deployment will include Training activities for Operations personnel by covering overall system review, standard product operation activities, how to handle simple problems that arise, reconciliation and investigation, accounting treatment, etc. Training for Business Development personnel should include necessary product information that can help business personnel understand

high-level functionality, system capabilities in dealing with different pricing mechanisms and SLAs and other capabilities that can help business development personnel sell your product capabilities and related software to our customers.

Maintenance

Maintenance is the final stage of the waterfall method where the finished software is run and system maintenance is carried out(Wahid, 2020).This stage is also the implementation of an application that has been designed directly to the user, and if an error is found in the program, then the error will be handled. Post deployment period will start after user usage of system so Team will provide amounts of resources to support on site during post deployment period and Team has to hand over the required knowledge to Improvement team. The team can also support during the Post deployment period who will be responsible for Monitoring and maintaining all processes and integration stability and all related systems so that they can address all issues when an incident occurs such as problem analysis, code investigation and problem solving. It can then provide immediate responses, suggestions, and proposed resolutions on each reported incident (based on severity). Any error that occurs will be treated as a production error and will be investigated, resolved, or corrected in accordance with the production SLA.

RESULT AND DISCUSSION

In general, to provide accurate problem identification results or low levels of academic satisfaction, researchers use fishbone analysis. The analysis used helps identify the root causes of problems, facilitates a better understanding of cause-and-effect relationships, and helps in designing suitable solutions. The shape of the diagram resembles a fishbone, draw a horizontal center line and add diagonal lines connected to the center line then the categories are usually related to the following. Below are the results of the fishbone analysis.

Figure 2 shows the 4 main factors which include:
1. Management is one of the factors that is the reason for this issue being raised because there is no supervision of academic guidance so that academic advisors and students cannot monitor it effectively and efficiently.
2. Material is the factor which is the reason for this issue being raised because there is no academic guidance application media and there is no report or concrete evidence in the form of digital student attendance and academic guidance reports.
3. Method is a factor in the absence of automatic schedule arrangements and the absence of optimal semester guidance report documents so that the

Head of the Study Program cannot know and monitor the level of effectiveness of academic advisor lecturers and students in carrying out academic guidance.

5.

4. Man is a factor that is an obstacle to the lack of knowledge and competence in the IT field so that they cannot keep up with industry 4.0 developments.
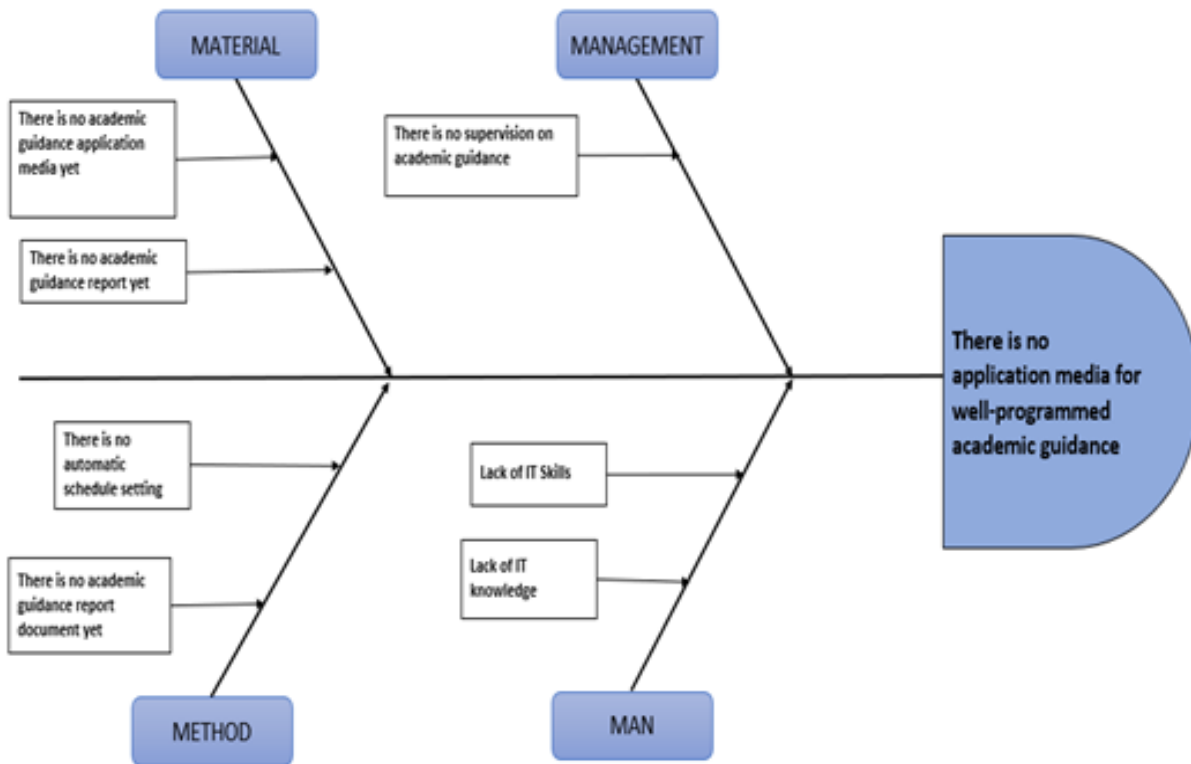

Fig. 2.Analysis Fishbone

After obtaining problem identification, the researcher conducts direct discussions with users about the need for an information system that will be created so as to produce system concepts and specifications that suit business needs. This e-consulting system was successfully built according to the requirements required by the system, so that this system is expected to be able to support and assist academic advisor lecturers and students in the process of academic guidance efficiently.

E-consulting Design

In the interview results, constraints during academic guidance were identified, especially related to the lecturer guidance menu and the student menu. User needs, both from lecturers and students, became clear during the interview process and formed the basis for the design of the e-consulting system. From the interviews, a profound understanding of the features needed in the system, such as online guidance capabilities, academic reporting, and user-friendly interfaces, was gained. Based on the analysis, database requirements were formulated, with MySQL as the DBMS, to support the storage and management of academic guidance data. The Waterfall development method was chosen to ensure that the stages of system development proceed in a structured manner, in line with user needs and expectations.

The technology used in the design of the e-consulting system uses a Hypertext Preprocessor or is called PHP with the CodeIgniter framework as a programming language (Figure 3.). CodeIgniter is a PHP framework created based on the View Controller (MVC) model (Sallaby & Kanedi, 2020). The data analysis process that occurs in the research system uses MySQL as a Database Management System (DBMS) using the basic Structured Query Language (SQL) commands which are easy to apply. This system design takes into account security and speed, critical aspects in an academic environment that prioritize confidentiality and efficiency. Special features for the lecturer guidance menu and student menu are designed to address the constraints identified during interviews. The interview process proved the importance of open communication between system developers and stakeholders to better understand needs and constraints. Below the figure contains lecturer data and study program data that has been inputted by the admin.

Fig. 3 Script Academic Guidance

Testing

The testing process can play an important role to ensure the system is delivered according to business requirements so that the test results can be used to improve product design Sanity Tests are required to perform pre-release sanity testing for testing, during design life or after development phases, bug fixes and updates. Researcher will provide test scripts before SIT, and it is the responsibility to develop test plans, test scenarios, and test scripts for SIT and UAT then researcher will jointly conduct sanity test before SIT

starts. The user has the right not to initiate SIT if key connectivity and functionality fails during a sanity test. After carrying out the implementation stage, the researcher carried out the system testing stage. From the final results of the tests that have been carried out in accordance with the scenario of business needs wants that researcher. Below table.1 is the application test.

Table 1 provides information about various scenarios or actions that can be performed by different user roles (Administrator, Head of Program Study, Academic guidance lecturer, and Student) in the system. Here is the meaning and significance of each column in the table 1:

The No column indicates the sequence number of each scenario or action outlined in the table. The Scenario column is a brief description of the scenario or action tested in the system. The Administrator column indicates whether the Administrator successfully executed a particular scenario ("Passed") or not ("-"). The Head of Program Study column indicates whether the Head of Program Study successfully executed a particular scenario ("Passed") or not ("-"). The Academic guidance lecturer column indicates whether the Academic guidance lecturer successfully executed a particular scenario ("Passed") or not ("-"). The Student column indicates whether the Student successfully executed a particular scenario ("Passed") or not ("-"). In scenario 9 "Edit Profile," all user roles (Administrator, Head of Program Study, Academic guidance lecturer, and Student) successfully executed the scenario ("Passed"). Conversely, in scenario 1 "Login an application," only the Administrator successfully executed it, while others did not ("-"). This table provides an overview of the success or failure of each user role in performing various scenarios in the E-Consulting system.

Table. 1. Application Test

No	Scenario	Administrator	Head of Program Study	Academic guidance lecturer	Student
1	Login an application	Passed	-	-	-
2	Export data	Passed	-	-	-
3	Add id lecturer and student	Passed	-	-	-
4	Search user id	Passed	-	-	-
5	Do enable and disable student	Passed	-	-	-
6	Add study program	Passed	-	-	-
7	Do edit study program	Passed	-	-	-
8	Distribute students to academic advisor lecturers	Passed	-	-	-
9	Edit Profile	Passed	Passed	Passed	Passed
10	Number of Guidance Students in this semester	-	Passed	-	-
11	The number of students guided by each lecturer	-	Passed	-	-
12	Number of lecturers who conduct guidance	-	Passed	-	-
13	Number of guidance schedule submissions	-	Passed	-	-
14	Dashboard on academic guidance activities	-	Passed	Passed	-
15	Send alert notifications to students	-	Passed	Passed	-

| No	Scenario	Administrator	Head of Program Study	Academic guidance lecturer	Student
16	Students who have Proposed Guidance Schedules	-	Passed	Passed	-
17	Students who have received guidance schedule	-	Passed	Passed	-
18	Students who re-schedule the guidance schedule	-	Passed	Passed	-
19	Submission of guidance schedule	-	Passed	-	Passed
20	Re-schedule guidance schedule	-	Passed	-	Passed
21	Cancel the tutoring schedule	-	Passed	-	Passed
22	Latest Noted from Lecturer Academic Advisors	-	Passed	-	Passed
23	Academic Advisor Lecturer Profile	-	Passed	-	Passed
24	Export guidance report every semester	-	Passed	-	Passed

Deployment

This stage is the stage of program design which becomes an integrated unit after conducting system testing (Figure 4.). Deployment will include training activities for users to know the system as a whole, operational activities of academic guidance then how to deal with simple problems that arise, reconciliation and investigation. Training for administrators including information on each menu on the required e-consulting system can help administrators understand the functionality and capabilities of the system. This training should include practice for system design, system management, and system troubleshooting. Training should cover provided solutions and hardware. View visitors can be accessed via a link that has been made by researchers http://e-consulting.poltekapp.ac.id/.
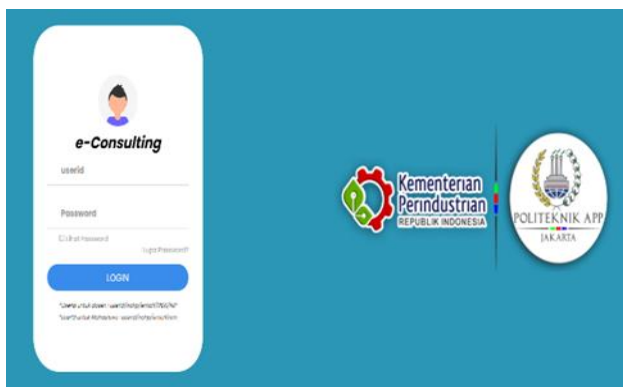

Fig. 4 Login Application

The main display on the admin consists of a dashboard to find out the total users, total students and total active academic advisor lecturers (Figure 5.). On this page the admin can find detailed user data reports, student data, Head of Study Program data, study programs, guidance lecturer data.
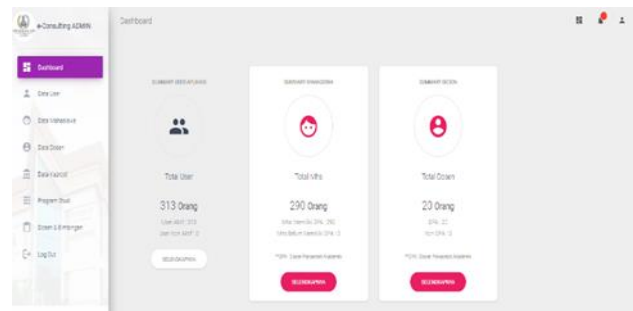
Fig. 5 Dashboard Administrator

On the user data menu admin can export data in excel format according to needs, admin can also add users if there is a need from academics on the add button. Student data menu (Figure 6.), admin can export data in excel format as needed, admin can also add students if there is an academic need, look for some needs from students using the filters provided and can do user enable on students who are still not disabled.
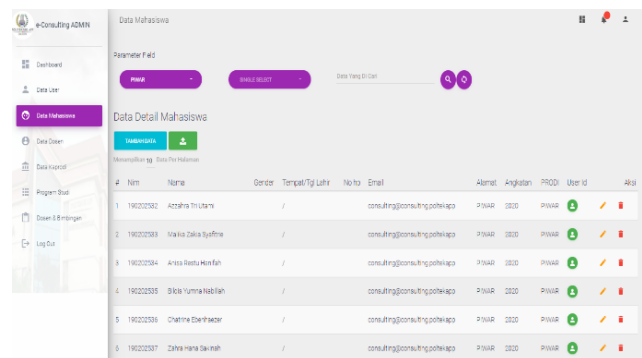
Fig. 6 Student Data Detail

Academic advisor lecturer data menu, admin can export data in excel format as needed, add lecturers according to academic needs on the add button, search for several academic advisor lecturers using the filters provided and admin can enable academic advisor lecturers who are still not disabled (Figure 7.).
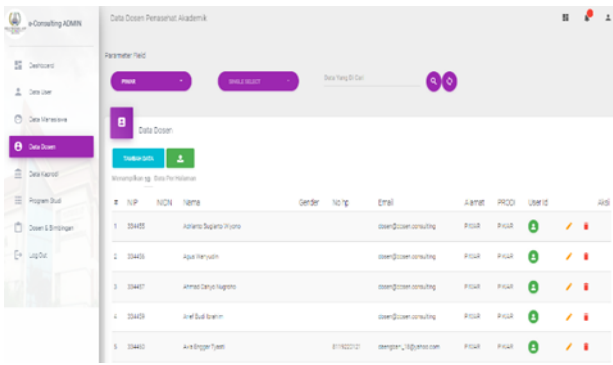
Fig. 7 Lecturer Data Detail

The main display on the Head of Study Program (Figure 8.) must be logged in and there is a dashboard to find out the number of guidance students, how many lecturers are conducting guidance, how many submissions for guidance schedules, how many guidance for each study program and find out trend reports in the form of line graphs on academic guidance activities.
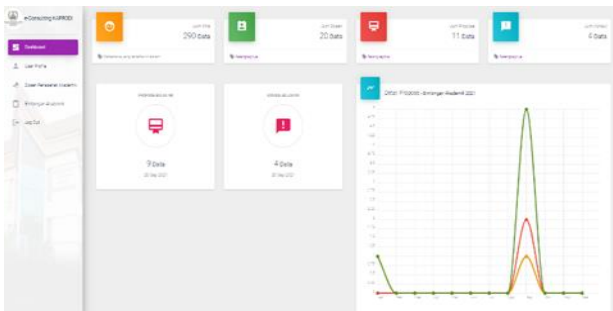

Fig. 8 Dashboard Head of Study Program

The main display on the academic advisory lecturer must be logged in and there is a dashboard to find out how many students have proposed the guidance schedule, how many students have received the guidance schedule, how many students have rescheduled the guidance schedule, the total number of guidance students this semester, how many guidance students for each study program (Figure 9.).
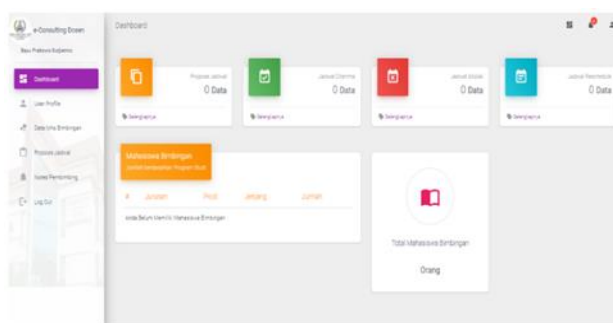

Fig. 9 Dashboard Lecturer Guidance Academic

The main display on Students (Figure 10.) must be logged in and there is a dashboard to find out how many guidance schedules have been submitted, how many guidance schedules have been received, how many schedules have been rescheduled, notifications from Academic Advisors, profiles of Academic Advisors for teaching lecturers.
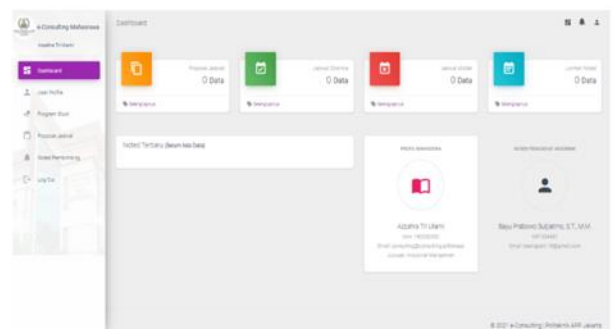
Fig. 10 Dashboard Student

Maintenance

The maintenance stage can be carried out by researchers in maintaining the system on a regular basis through data backup and system upgrades as well as application security levels. The author provides textbooks for administrators if there is additional data such as students for new batches and cleaning data for students who have graduated then for data for academic advisors and retired lecturers.

CONCLUSION

Based on the application of the results of the e-consulting system design, it is an effort to form an innovative learning system. The e-consulting system is carried out using the PHP programming language and a web-based MySQL database. The waterfall model in designing the resulting e-consulting system will be good because the implementation is carried out in stages and systematically.

The e-consulting system can facilitate the academic guidance process because it can be done anytime and anywhere easily and effectively. Through the e-consulting system the quality of education can be improved so that education can be evenly distributed by all levels of society and have quality human resources that are ready to use and have global competitiveness. The e-consulting system provides convenience in interacting and establishing communication effectively and efficiently. Implement a robust documentation system that records communication history can aid in efficient tracking and retrieval of information. It then ensures that the documentation provides a comprehensive overview of the communication, assisting in effective decision-making and problem resolution.

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