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Development of a Virtual Control System for Learning Implementation

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ABSTRACT: *This This study focuses on system development research aimed at creating a virtual control system for managing university lecture attendance. The research was conducted within the Faculty of Mathematics and Natural Sciences, Universitas Negeri Makassar. In this development process, the top management comprises faculty leaders, the system developers are staff from the Information and Communication Technology (ICT) unit, and the users are faculty lecturers. The development of the information system in this study follows the PADM model, which consists of four stages: Planning, Analysis, Design, and Maintenance. The success of the research is assessed based on the efficiency and effectiveness of time and cost utilization during system development, as well as stakeholder responses (including top management, users, and system developers) collected through questionnaires. These questionnaires aim to capture users' perspectives on the developed information system. The findings indicate that stakeholders' satisfaction levels fall within the "satisfied" category. Furthermore, the study reports no significant obstacles related to time or cost during the system development process.*

Keywords: *development, control system, virtual, PADM model, lecture*

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I. INTRODUCTION

Control is a critical component in the operation of any system, as it ensures that the system functions as intended over time [1]. Within the context of educational institutions, the Faculty of Mathematics and Natural Sciences at Universitas Negeri Makassar (FMIPA UNM) has also implemented measures to monitor and regulate the lecturing process. However, challenges have recently arisen in maintaining effective oversight. Class representatives, who are responsible for managing attendance monitoring sheets, occasionally fail to collect these sheets. Consequently, lecturers may not fill in the attendance records, and the sheets are sometimes misplaced. This creates difficulties in enforcing academic regulations, particularly the rule that students must attend at least 80% of the 16 scheduled meetings each semester.

The reliance on paper-based systems to manually control student attendance has become increasingly burdensome, particularly during the Covid-19 pandemic. Key strategies for mitigating the spread of Covid-19 include social distancing, adopting new technologies, and adapting workplace policies and procedures [2]. The use of internet-based solutions has gained significant prominence, as highlighted in various studies [3-5]. Over the past decades, researchers have developed innovative internet-based control systems to monitor and manage industrial processes remotely. These developments underscore the importance of leveraging similar technologies in the academic context to address attendance-related challenges. Specifically, research strongly supports the creation of e-Absence systems to streamline the recording of lecturer and student attendance, as well as the documentation of lecture topics covered in class [2-4][6-8]. Such systems can enhance efficiency and ensure compliance with academic regulations while adapting to the demands of modern educational environments.

The development of such a control system requires a clear understanding of the concepts of a system and a control system. A system can be defined as a set of components organized in a structured manner to achieve specific objectives [9]. The implementation of distance learning, remote learning, or online learning necessitates the presence of a control system. Scholars such as Dorf & Bishop, Nise, and Golnaraghi & Kuo have extensively discussed the concept of control in the context of systems [10-12]. Based on their definitions, a virtual control system for lecturing can be understood as an interconnection of components that virtually configure a system capable of responding to expected virtual outputs. Additionally, in such a virtual control system, an input-output relationship exists, representing the causal dynamics of the lecturing process controlled in a virtual environment.

To address the identified challenges in developing a virtual control system for lecturing, the

functionalism paradigm offers a relevant framework [13]. This paradigm is characterized by four key perspectives. First, it identifies the main actors, including management, system developers, and users, all of whom play critical roles in the system's development and operation. Second, it emphasizes a narrative focused on developing an information system designed to support the operations of a rational organization while ensuring effective and efficient project management. Third, it highlights the plot, which involves maximizing benefits or achieving optimal outcomes. Lastly, it is underpinned by the assumption that system developers, grounded in a positivist epistemology, gain insights into the organization by analyzing measurable cause-and-effect relationships. This framework provides a robust basis for designing and implementing a virtual control system tailored to the specific needs of online lecturing environments.

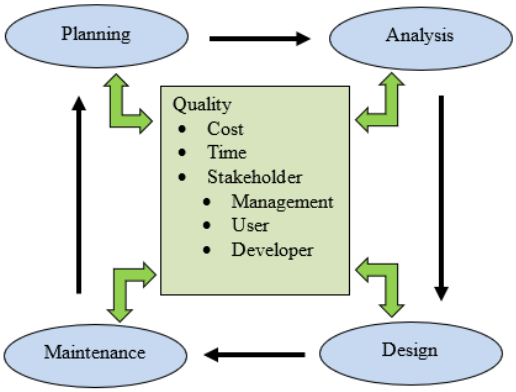


Fig. 1 PADM model

II. METHODS

This research is a system development study based on the framework proposed by Nunamaker et al. [14]. The study was conducted over a six-month period, from March to August 2020, at FMIPA UNM. Participants included 30 lecturers representing each department within the faculty, five senior leaders serving as top management, and three staff members from the Information and Communication Technology (ICT) unit functioning as system developers. The research employed the PADM Model—Planning, Requirement Analysis, Design, and Maintenance—as outlined by Nayan and Zaman [15].

III. RESULTS AND DISCUSSION

RESULTS

The research findings are presented according to the stages of the information system development process within the PADM Model, as outlined below.

Planning

In this stage, there are seven important points as the following.

First, Goal and objective. The goal of developing this system is to monitor the implementation of lecturing in FMIPA UNM, particularly in the time of pandemic Covid-19.

Second, User requirement. The requirement of lecturer in FMIPA UNM is e-absence or e-Absence.

Third, Scope. This control system development is limited to e-absence. The scope of the e-absence includes four main aspects to monitor, namely, lecturers' names handling the lecturing, the time of conducting the lecturing, courses and the topic of lecturing conveyed, and students' attendance. The goal of developing this system is to monitor the implementation of lecture in FMIPA UNM, particularly in the time of pandemic Covid-19.

Fourth, Cost. The control system development was carried out using funding provided by Universitas Negeri Makassar. There are two types of costs in this development, i.e., the cost of renting a server and the cost of building and maintaining the system.

Fifth, Time. The development of this control system has been started since the even semester of the 2019/2020 academic year.

Sixth, Resources. The development of this control system was carried out by the ICT Team of FMIPA UNM. The developer employed in this research were professionals. In question is the UNM ICT Center Programmer in 2013-2018. They also were a part of the School Website Development Team of the Research and Development Board of the Ministry of National Education in 2015-2018.

Seventh, Risk. It is often interpreted as an unpleasant result of an action. In this case, the risk referred to

is in relation to the development of a virtual control system for the implementation of lectures. It is recognized that there is a risk from developing this system, namely that the information system being developed depends on the existence of an internet quota and an internet connection.

Analysis

The project aims to develop a virtual control system for managing lecture implementation at FMIPA UNM, particularly in response to the challenges posed by the Covid-19 pandemic. According to Avison and Taylor, information systems analysts must identify the fundamental characteristics of the environment in which an information system will be developed and select an appropriate methodology or contingency approach tailored to the specific system [16]. They classify problem situations into five types: well-structured situations with clearly defined problems and requirements, well-structured situations with clear objectives but uncertain user requirements, unstructured situations with unclear objectives, situations involving high user interaction with the system, and complex situations that combine elements of the first four categories. Based on these classifications, FMIPA UNM's situation falls under the first type—well-structured problem situations characterized by clearly defined problems and requirements. Specifically, the pandemic-induced challenges in managing lectures represent the well-structured problem, with the attendance of lecturers and students being the clearly defined issue and the specific requirements for system development.

The user requirements for this system primarily address the needs of FMIPA UNM lecturers, particularly for an electronic attendance or presence (e-Absence) system. The development of this virtual control system is limited to implementing electronic attendance functionalities, encompassing four key aspects: identifying the lecturer conducting the lecture, recording the time of the lecture, specifying the course name and lecture topic, and tracking student attendance. The main stakeholders in the development process include FMIPA UNM management, who provide oversight and define the expected outcomes, and the system development team, comprising three ICT experts—one programmer and two analysts—tasked with transforming the project goals into a functional virtual lecture control system. The end-users of this system are the lecturers, who will interact with the system to achieve FMIPA UNM's objectives.

The project also recognizes potential risks and problems inherent in the development and implementation of the system, particularly its reliance on internet connectivity and data quotas. These risks directly impact the functionality and reliability of the system, implying that mitigating such risks is essential to minimizing the emergence of associated problems. The successful development and deployment of this virtual control system thus depend on addressing these challenges effectively.

Design

The control system was developed using the CodeIgniter framework for programming, integrated with a MySQL database. The outcomes of the system design are illustrated in Figure 2, which presents the initial interface of the developed control system. This interface provides access to the system through a login mechanism, requiring the *Sistem Informasi Akademik* (SIA) username and password assigned to each lecturer at Universitas Negeri Makassar.

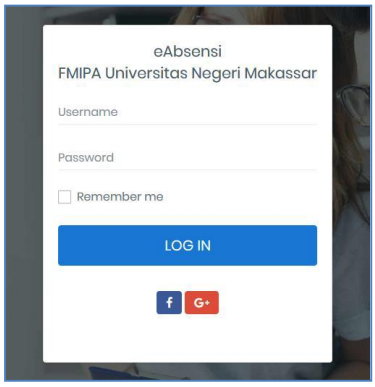


Fig. 2 Start page of Prototype I e-Absence

Figure 2 represents Prototype I, which displays the initial view of the e-Absence system accessible via the link http://absensi.fmipa.unm.ac.id. This display has undergone significant modifications following the integration of e-Absence with the Integrated Management Information System (SMART) of FMIPA UNM. The term "SMART" reflects the aspiration for advancing information technology at FMIPA UNM, as articulated by Elbanna et al. [17]. According to Elbanna et al., SMART entails the intelligent and rational utilization of resources to work, organize, and live effectively and efficiently, promoting well-being and benefiting individuals, society,

humanity, and the physical environment. Within the context of system development, the concept of SMARTNESS, as defined by Alter [18], refers to the classification of intelligent capabilities organized into four categories: information processing, internal regulation, action in the world, and knowledge acquisition. The modified version of the system, referred to as Prototype II, is accessible via the link https://smart.fmipa.unm.ac.id/#login. The revised display of Prototype II is presented as follows.

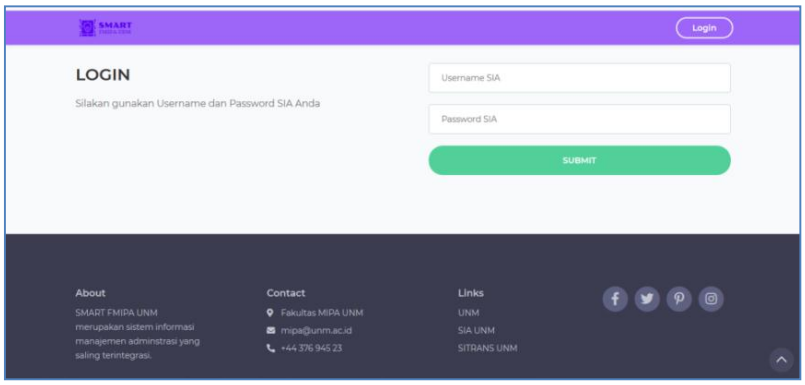


Fig. 3 Start page of Prototype II e-Absence

When the username and password specified in this Prototype II are entered and the Login or Submit button is clicked, the subsequent screen will be displayed.

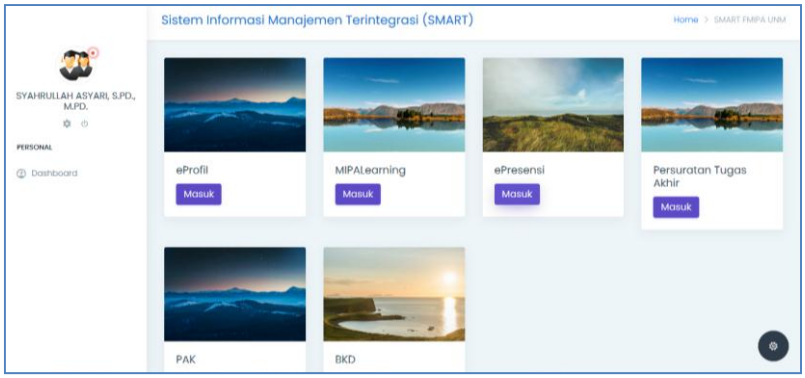


Fig. 4 After login or submit Prototype II e-Absence

After logging in or submitting, the interface displayed resembles Figure 4 above, featuring six menus: eProfil, MIPALearning, ePresensi, Final Project Letter, Credit Score Assessment (PAK), and Lecturer Workload (BKD). This Prototype II extension integrates seamlessly with other previously developed Information Systems, enhancing functionality and connectivity. To access the Virtual Attendance feature, users can select the ePresensi menu from the displayed options. Upon clicking ePresensi, the corresponding screen will be presented.

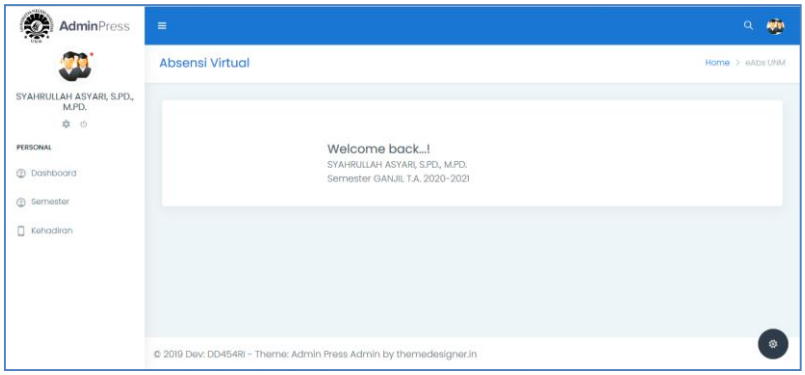


Fig. 5 Virtual attendance after clicking the "e-Presensi" menu

The display features three main menus: dashboard, semester, and attendance. The dashboard serves as the primary interface for the virtual attendance system. The semester menu provides options for selecting the current semester. Meanwhile, the attendance menu includes course data and various submenus designed to facilitate the monitoring of lecture activities, aligning with the objectives of this control system's development.

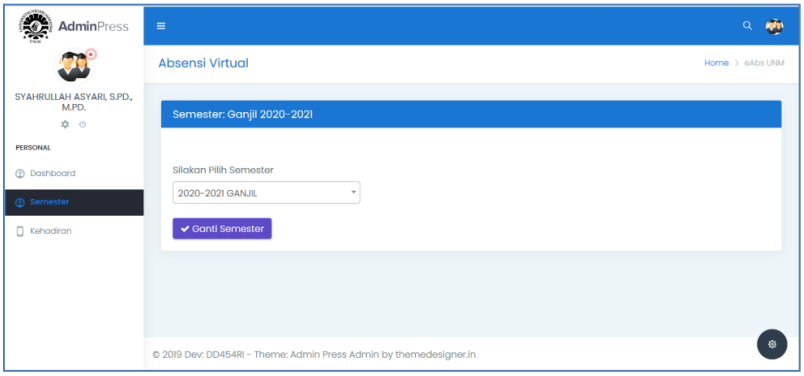


Fig. 6 Virtual attendance after clicking the "Semester" menu

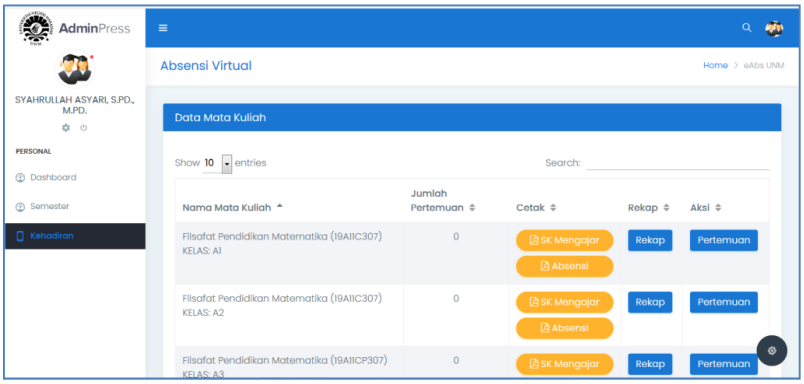


Fig. 7 Virtual attendance after clicking the "Pertemuan" menu

When the user clicks the "Pertemuan" option, the system will display the interface shown in Figure 8. In this interface, users can input various lecture-related data, including the course name, the designated classroom, the scheduled lecture time, the class, the semester, and the current academic year. Additionally, users can manage lecture meetings by specifying the number of sessions, their respective schedules, the topics to be covered, and by tracking student attendance.

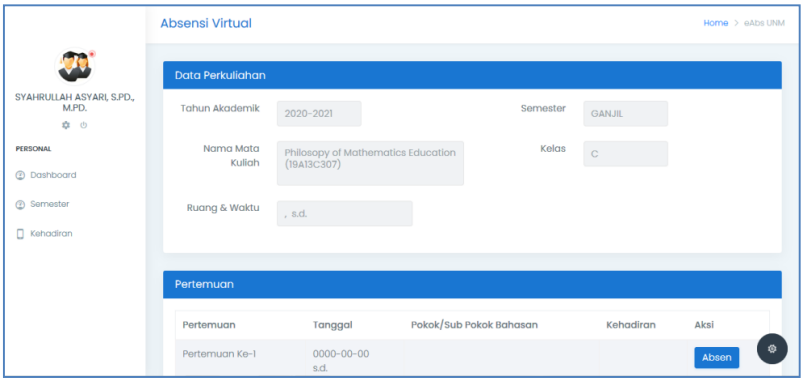


Fig. 8 Virtual attendance after clicking the "Pertemuan" menu

When the user clicks "Absen" in Figure 8, the system redirects them to the student attendance list interface, where they can record attendance for lectures, as illustrated in Figure 9. In this interface, users are prompted to input lecture details and specify the attendance status of each student, categorized as present, absent, excused, or sick. By default, the system automatically assumes students are present, simplifying the process for

users by requiring input only for exceptions. This default setting is designed to streamline the attendance process, given that student absences are typically incidental.

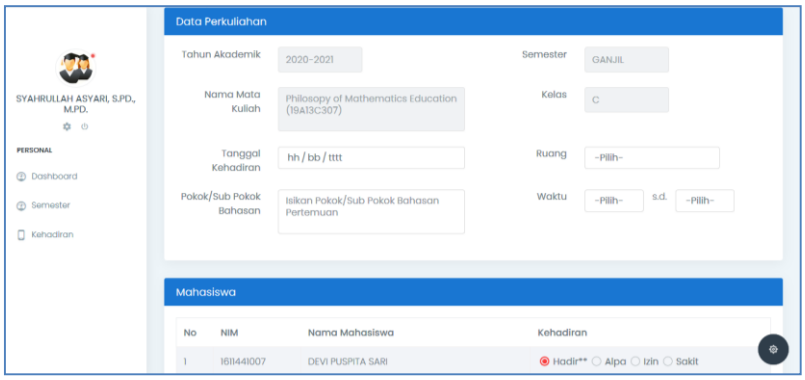


Fig. 9 Virtual attendance after clicking the "Timesheet" menu

Referring back to Figure 7, in addition to the "Pertemuan" menu, the system also features a "Rekap" menu. This "Rekap" menu directs users to a recapitulation of lecture data, particularly focusing on student attendance during lectures, as illustrated in Figure 10. In this figure, users can view the percentage of student attendance, providing a clear representation of attendance data in quantitative terms.

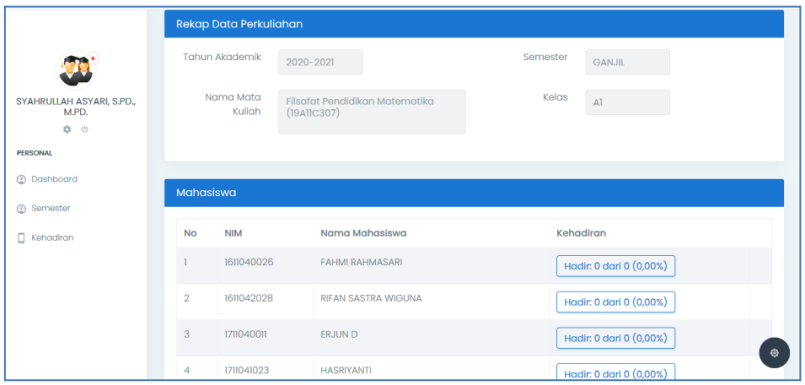
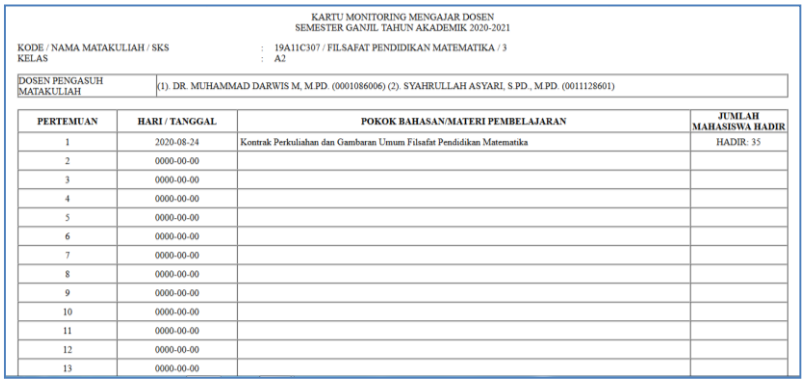


Fig. 10 Virtual attendance after clicking the "Rekap" menu



KARTU MONITORING MENGAJAR DOSEN
SEMESTER GANJIL TAHUN AKADEMIK 2020-2021

KODE / NAMA MATAKULIAH / SKS : 19A11C307 / FILSAFAT PENDIDIKAN MATEMATIKA / 3
KELAS : A2

DOSEN PENGASUH MATAKULIAH: (1). DR. MUHAMMAD DARWIS M, M.PD. (0001086006) (2). SYAHRULLAH ASYARI, S.PD., M.PD. (0011128601)

PERTEMUAN	HARI / TANGGAL	POKOK BAHASAN/MATERI PEMBELAJARAN	JUMLAH MAHASISWA HADIR
1	2020-08-24	Kontrak Perkuliahan dan Gambaran Umum Filsafat Pendidikan Matematika	HADIR: 35
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Fig. 11 Virtual student attendance after clicking the "attendance" menu

Figure 7 illustrates the print menu, which includes the Teaching Letter of Decree (SK) menu for printing the SK document assigned to lecturers and the "Kehadiran" menu for generating a printed lecture attendance list, as depicted in Figure 9. When the user selects the "Kehadiran" menu, the system generates and displays a printed attendance record, as shown in Figure 11. This printed attendance sheet also includes the name of the lecturer responsible for the course, as specified in the SK document.

To observe evidence of e-Absences usage by lecturers across all departments and study programs within FMIPA UNM, visitors can access the website at http://absensi.fmipa.unm.ac.id/index.php/rekap/cetak. Figure 12

presents a recapitulation of e-Absences, displaying lecturer attendance in lectures, while Figure 13 illustrates an example of the interface shown when a visitor clicks on the blue feature indicating the names of study programs within FMIPA UNM.

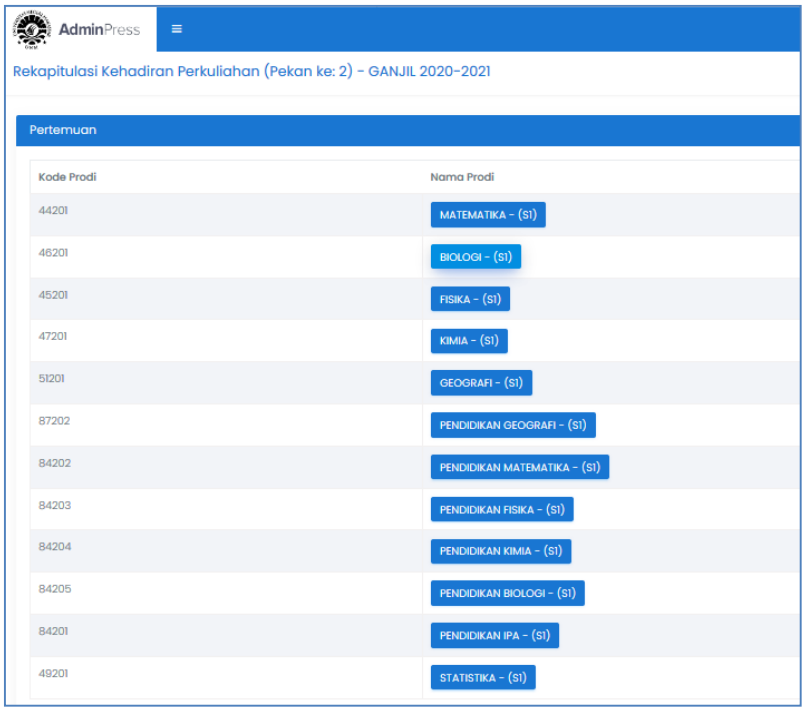

Fig. 12 Recapitulation of lecturer attendance

Rekapitulasi Absensi: MATEMATIKA - (S1)
Pekan ke: 2
Update: 29 Agustus 2020 Pukul 16:13:15 WITA

No.	Kode	Mata Kuliah	Kelas	Dosen	Jum. Pertemuan
1	17A12C304	GEOMETRI ANALITIK	B	• FAJAR ARWADI, S.PD, M.SC (0004108701) • DRS. MUHAMMAD DINAR, M.PD (0009085607)	0
2	17A12C501	PROGRAM LINIER	B	• SUTAMRIN, S.SI., M.PD. (0005098206) • SUKARNA, S.PD, M.SI (0013037305)	1
3	17A12C502	ANALISIS REAL II	B	• SYAMSUDDIN MAS'UD, S.Pd, M.Sc (0012069002) • DR. ILHAM MINGGI, M.SI. (0030036503)	1
4	17A12C503	STRUKTUR ALJABAR II	B	• PROF. DR. SURADI TAHMIR, M.S. (0013046401) • SAHLAN SIDJARA, S.SI, M.SI. (0016128801)	2
5	17A12C504	METODOLOGI PENELITIAN	B	• DR. HISYAM IHSAN, M.SI. (0026126501) • MUHAMMAD ABDY, M.SI., PH.D. (0029016903)	0
6	17A12C505	PEMODELAN MATEMATIKA	B	• PROF. SYAFRUDDIN SIDE, S.SI., M.SI., PH.D. (0002027204)	1
7	17A12C506	KOMPUTASI MATEMATIKA	B	• MAYA SARI WAHYUNI, S.T., M.KOM. (0005017109) • SULAIMAN, S.SI., M.KOM., M.M. (0024067405)	0
8	17A12C507	KAPITA SELEKTA	B1	• PROF. SYAFRUDDIN SIDE, S.SI., M.SI., PH.D. (0002027204)	1
9	17A12C507	KAPITA SELEKTA	B2	• DR. WAHIDAH SANUSI, S.SI., M.SI. (0009047001)	2
10	17A12C507	KAPITA SELEKTA	B3	• SUKARNA, S.PD, M.SI (0013037305)	1

Fig. 13 The recapitulation of attendance for lecturers in the Department of Mathematics during their teaching sessions

Figure 7 illustrates the print menu, which includes the Teaching Letter of Decree (SK) menu for printing the SK document assigned to lecturers and the "Kehadiran" menu for generating a printed lecture attendance list, as depicted in Figure 9. When the user selects the "Kehadiran" menu, the system generates and displays a printed attendance record, as shown in Figure 11. This printed attendance sheet also includes the name of the lecturer responsible for the course, as specified in the SK document.

Maintenance

During the maintenance stage of the system, several key aspects are addressed to ensure optimal performance and usability. The first aspect involves support, which includes the maintenance of the system as a

preventive measure against potential issues during its operation. To mitigate risks of system malfunction that could harm users, the developer performs daily data backups to safeguard the system. Additionally, a user manual in the form of a tutorial for operating the FMIPA UNM e-Absence system has been provided by the developer. This tutorial is accessible through the following YouTube link: https://www.youtube.com/watch?v=sj4JatFL0ps. The second aspect pertains to changes implemented in response to user feedback, such as modifying the initial system interface, as illustrated in the transition from Figure 2 to Figure 3. These adjustments were made to improve user experience based on their specific requests. The third aspect focuses on enhancements aimed at improving system quality by addressing technical elements such as data transmission rates, storage capacity, and CPU performance. These improvements ensure that the system is accessible across various devices, including laptops, Android devices, and other smartphones. Finally, updates were carried out to integrate the e-Absence system into SMART FMIPA UNM. Previously a standalone system, e-Absence was integrated with other related information systems to streamline access for users, as depicted in Figure 3. This integration enhances the system's functionality and convenience for its users.

DISCUSSION

This section discusses the success of the control system developed, evaluated from three key aspects: cost, time, and stakeholders (including management, system developers, and users). These three aspects are considered the primary determinants of the success of an information system [15]. Clear identification and alignment of perspectives regarding the project development scope are essential. The scope must align with the allocated cost and time, as well as the resources designated for system development. Efficient supervision is critical; without it, the project may exceed the established cost and time limits [15]. In this research, the development project focused on an electronic attendance system (e-Absence), which adhered to the allocated cost and time. The e-Absence system is already being utilized by users, including lecturers and faculty leaders, to monitor and control lecture implementation in FMIPA UNM.

Numerous studies emphasize that neglecting user needs often leads to the failure of information system development projects, as users may refuse to adopt the system [15]. Therefore, user satisfaction is often regarded as a critical determinant of project success. While this rationale appears sound, it has faced criticism from researchers [19], who argue that user satisfaction holds limited value if the developed system does not improve individual performance or the overall organizational efficiency. Further studies suggest that active user involvement in assessing the developed system significantly influences user satisfaction and determines the system's success and quality [20]. However, the terms "user satisfaction," "system success," and "system quality" are often used interchangeably, leading to ambiguity. User satisfaction is sometimes equated with system quality or used as a proxy for measuring it. Such an approach introduces subjective biases in assessing system quality [21].

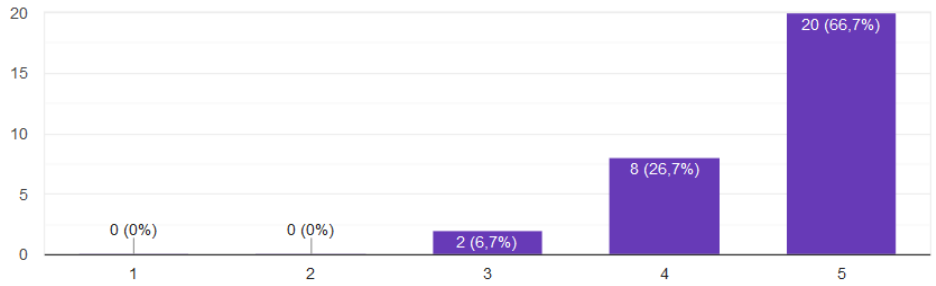

Fig. 14 The lecturer satisfaction towards e-Absence

Despite differing opinions among experts regarding the importance of user satisfaction as the primary determinant of project success, this study adopts user satisfaction as a critical measure. Within this context, user satisfaction is deemed highly significant, as it drives the advancement of better information and communication technology systems for higher education at Universitas Negeri Makassar, particularly in the Faculty of Mathematics and Natural Sciences. The findings on lecturer satisfaction as users of the e-Absence system reveal that 6.7% of lecturers responded neutrally, 26.7% agreed, and 66.7% strongly agreed. This indicates that the majority of lecturers in the Faculty of Mathematics and Natural Sciences responded positively to the e-Absence system overall. The capabilities of the e-Absence system, developed to meet lecturers' needs in performing their responsibilities related to attendance management, have been evaluated. The findings indicate that 80% of the lecturers expressed strong agreement regarding its effectiveness, while the remaining 20% reported agreement.

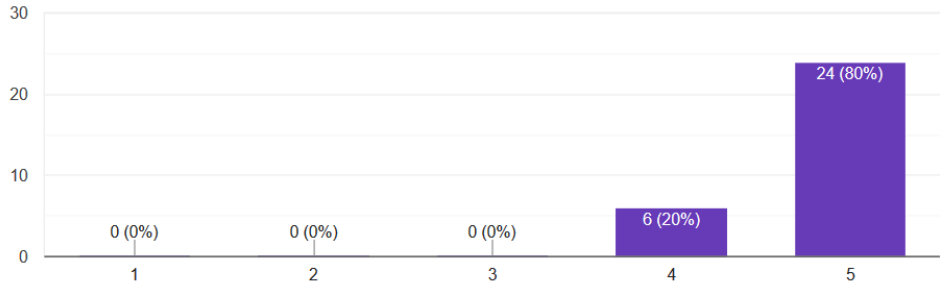

Fig. 15 The satisfaction of lecturers with the ability of the e-Absence system to meet their needs in fulfilling their professional responsibilities

Based on the user satisfaction questionnaires, it can be concluded that the satisfaction level of lecturers in FMIPA UNM falls within the satisfied category. The user satisfaction data primarily aim to capture users' perspectives on the information system and to assess the technical quality of the developed system. This implies that user satisfaction is more focused on measuring perceptions of the facilities or features provided by the system, rather than evaluating its functional capabilities [22]. Furthermore, user feedback highlights the importance of digital transformation in this context [23]. In addition to the user satisfaction questionnaires, this study also included evaluation questionnaires on the e-Absence system conducted by the faculty's top management, comprising the dean and four vice-deans. The evaluation results indicate that the top management is wholly satisfied with the performance of e-Absence, particularly in meeting the needs of lecturers in fulfilling their responsibilities. Among the five leaders in the faculty, four strongly agreed, and one agreed, that e-Absence effectively supports the lecturers in completing their tasks. Thus, it can also be concluded that the top management is satisfied with e-Absence's capacity to address the lecturers' needs.

Considering the responses and suggestions from e-Absence users, along with the evaluation results from the top management, it is evident that the relationship between user participation and their satisfaction level is significantly influenced by the support of top management. This support acts as a moderating variable in the relationship between user participation and the success of the information system [24]. This research acknowledges that the support of top management has been exceptionally significant in ensuring the success of e-Absence. Whether in terms of financing the server and its maintenance or providing incentives for system developers, all aspects have been fully supported by the top management. Therefore, it is reasonable to conclude that e-Absence has been developed effectively and efficiently, enabling its use during the Covid-19 pandemic.

IV. CONCLUSION

Based on the research findings, it can be concluded that the development of the virtual control system for lectures in the Faculty of Mathematics and Natural Sciences at Universitas Negeri Makassar employs the PADM model, which includes Planning, Analysis, Design, and Maintenance. The level of satisfaction among lecturers in the faculty falls into the "satisfied" category. Additionally, the top management has expressed satisfaction with the overall implementation of the e-Absence system. They also acknowledge the system's effectiveness in meeting the requirements related to lecturers' responsibilities. Furthermore, the top management has stated that the e-Absence system facilitates the enforcement of academic regulations regarding student discipline in attending lectures. Consequently, the system also supports the implementation of consequences for violations of these regulations.

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