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Development of Information and Management System of Student Competition Groups Using User-Centered Design Approach

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Abstract—The majority of universities in Indonesia make maximum efforts to participate and excel in the implementation of the Student Creativity Program (namely: PKM). PKM requires students to collaborate interdisciplinary or multidisciplinary. The problem at the beginning of PKM implementation is establishing groups, where students find it difficult to have fellow students or supervisors from different disciplines in groups and according to the topic of their PKM. This research develops user-oriented interaction and interface of information system and group management. Development was carried out through a User-Centered Design which consisted of the following stages: plan the human-centered process; understand and specify the context of use; specify the user requirements; produce design solutions to meet user requirements; and evaluate the design against the requirements. Testing using System Usability Scale (SUS) and User Experience Questionnaire (UEQ) approach were conducted on 30 respondents who had competencies as business analysts, programmers, and testers. The results of the mean score of the SUS test are 80, and the mean Score of the UEQ test on the Attractiveness variable is 1.922, Clarity is 2.158, Efficiency is 2.042, Accuracy is 1.708, Stimulation is 1.967, and Novelty is 1.917. The system has achieved the goals and user experience because all the testing scores are above the standard provisions.

¹⁵ **Keywords**— Student Creativity Program, User-Centered Design, System Usability Scale, User Experience Questionnaire.

I. INTRODUCTION

As college graduates, students are required to have academic knowledge, thinking skills, management skills and communication skills [1]. The Indonesian government by the Directorate General of Higher Education always strives to accelerate the improvement of student competencies in the form of Student Creativity Program competitions (namely: PKM). PKM activities aim to realize creative, innovative, productive and competitive students in line with the character of Pancasila [1]. The level of student participation in PKM implementation grants during 2019 to 2020 had increased from 3,621 to 4,522 proposals [2]–[4].

PKM requires students to collaborate interdisciplinary or multidisciplinary. The implementation of PKM that is multidisciplinary can become a priority for funding grants because it is able to contribute to the social humanities and exact fields. The problem commonly faced at the beginning of PKM implementation is to build collaboration between students or collaboration between students and supervisors, where students found it difficult to have other fellow students

or supervisors from different disciplines in their groups and according to the topic of PKM. In the era of the Covid-19 pandemic which requires students to work independently, it also leads to greater difficulties for establishing multidisciplinary collaborations.

The majority of universities in Indonesia make maximum efforts to participate and excel in the implementation of PKM. The result of PKM implementation affect the increase of student and university achievement in the ranking set by the Ministry of Education and Culture [1]. Research studies on previous scientific research articles were carried out to identify the forms of information system implementation of PKM in a university. Research [5] developed a mobile application that aimed to display PKM implementation information messages through push notifications on android devices and short message services on basic devices. Research [6] built a website that aimed to convey information on PKM guidelines and PKM coordinator management in each study program. Research [7] also built websites that aimed to convey information on the implementation of PKM and manage data on PKM proposals. The focus of the research [5]–[7] was to build a system that functions to convey infor-

mation on the implementation of PKM but did not provide a functional website to manage the establishment of the PKM group.

The level of functional usability and user satisfaction with a system is a success indicator of developing an information system [8]. The usability variable in an information system refers to the ability to learn, efficiency, memory, error prevention ability, and the ability to provide pleasant interaction of a system [9]. Thus, the mechanism for developing user-oriented applications or information systems can be done through a User-Centered Design (UCD) approach. UCD is an approach of applications or information systems development that is oriented towards user requirements by considering psychological, cognitive, cultural, and other variables.

Further scientific research studies were conducted on the topic of application and system development through the UCD approach. The development of mobile-based applications and web-based systems through the UCD approach had been carried out such as: research [10] developed a mobile application for learning computational thinking for children, research [11] developed a mobile-based educational game for learning English vocabulary for children, research [12] developed a mobile application for the implementation of counseling guidance for adolescents, research [13] developed a website in the form of e-learning for students in universities, research [14] developed a website for learning the philosophical values contained in batik motifs, and research [15] develop a website-based information system for learning on Anti-Money Laundering and Terrorism Financing Prevention in Indonesian government agencies. The results of further research studies showed that the UCD approach had been applied to the development of mobile applications and websites in education or other fields, but no research had been found that was specifically applied to competition activities.

This research discusses the development of information system interactions and interfaces in the management of competition group preparation through the UCD approach as a form of novelty on the artifacts dimension. The research process involved several stakeholders, such as the head of the student bureau and alumni, students, PKM Center administrators, and the programmer team. The output in this research was a high-fidelity prototype with the name UAD Juara. The evaluation process of the research results was carried out through System Usability Scale [16][17] and User Experience Questionnaire [18][19] approach.

II. METHODS

This section describes each systematic stage in the website development for the management of the student competition group at Universitas Ahmad Dahlan called UAD Juara. The interaction and interface design process for the UAD Juara website was carried out through User-Centered Design (UCD) approach. This approach puts users at the center of the website development process to ensure that the resulting product maintain usability value and a good user experience. There were several methodologies used in UCD, such as Albani-Lombardi, Lowdermilk, and ISO 9241-210: 2010. This research applied the ISO methodology because it is one

of the widely used methodologies and included five main stages as shown in Fig. 1.

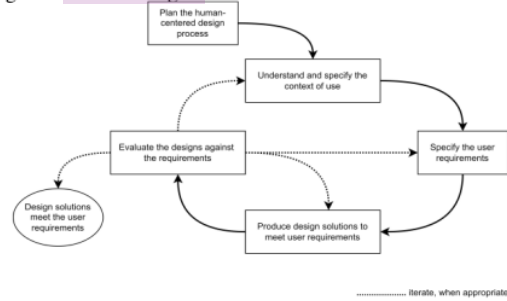


Fig. 1 User-Centered Design (ISO 9241-210:2010)

A. Plan the Human-Centered Design

The first stage in UCD was the Plan the Human-Centered Process, where researchers collected secondary data through literature review sourced from books, scientific articles, papers, and references from the internet. In the first stage, primary data collection also was carried out through brainstorming between researchers and the head of student affairs and alumni bureau, students, PKM Center administrators and the programmer team.

B. Understand and Specify the Context of Use

The second stage in UCD was the process of identifying user characteristics, system development objectives, user environment in using the system, and determining the minimum and optimal requirements of the system. The identification process was based on the results of primary data collection in the first stage.

C. Specify the User Requirements

The third stage in UCD was the process of analyzing user requirements for the website explicitly in the form of several statements that contained "what the website can do to meet user requirements". User requirements would describe the tasks performed by users as an integral part of business operations. The identification process was also based on the results of primary data collection in the first and the second stage.

D. Produce Design Solution to Meet User Requirements

The fourth stage in UCD was the process of compiling concrete solutions in the form of website design using the Use Case Modeling and Website Prototypes based on the results of user needs analysis. Use case diagrams would be applied to describe the interaction connection between users and the system, and the final output of this stage was a high-fidelity prototype that displayed a design with a high level of precision.

E. Section Headings

The final stage in UCD was the evaluation process carried out through the System Usability Scale [16][17] and User Experience Questionnaire [18][19] approach. The results of the evaluation by the user could be a recommendation for improvement in optimizing the final result of the system, and it was carried out iteratively until the system development goals were met.

III. RESULT AND DISCUSSION

The first result of the plan the human-centered process stage was the collection of secondary data sourced from scientific study with the topic of efforts to develop applications or information systems through the UCD approach, and efforts to implement applications or information systems in the implementation of PKM. The results of scientific study data showed that there was no application or system development through the UCD approach found that focused on the management of competition group. The second result was the primary data collection sourced from brainstorming activities between researchers and several stakeholders such as the head of the student affairs bureau and alumni, PKM Center administrators, students, and the programmer team to build a commitment to participation in this research.

The result of the understand and specify the context of use stage was identifying five main topics sourced from the primary data collection through brainstorming activities. The first discussion related to user characteristics was identified into 2 categories, which were the category of managers consisting of the head of staff of the student and alumni bureau and PKM Center administrators, and the category of users who were active students. The second discussion was related to the purpose of developing the system, that the existing system functioned as a medium for delivering information, and the development of the system aimed to accommodate the preparation of the competition group. The third discussion regarding the environment where the system was used, identified that the results of system development must be responsive and able to accommodate access via mobile and desktop devices from the internal and external internet network of the university. The fourth discussion related to the minimum functional system requirements identified that the results of system development must have standard functionalities as the delivery of information on the implementation of student competition activities. Finally, the fifth discussion related to the optimal functional system requirements identified that the results of system development must have a management function for the establishment of competition groups.

The result of the user requirements stage was to specifically describe user needs and system functional requirements based on the results of primary data collection through brainstorming. Details of the results of the identification of user needs and system functional requirements are shown in Appendix section.

The result of the produce a design solution to meet user requirements stage was to create a system design using the use case modeling and prototype based on the results of user needs analysis. Use Case Diagram showing the form of user interaction with the system is presented in Fig. 2.

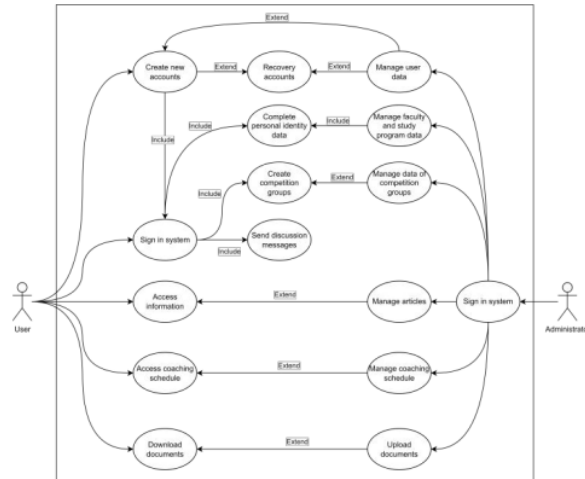


Fig. 2 Use Case Diagram

The result of the preparation of the use case diagram was then translated into a more concrete form, namely high-fidelity prototype with the Laravel framework. The system design was built to meet the two main needs of users, that were obtaining information and forming student groups for competition. The home page would display all competition information through a menu bar and page sections that could be accessed without sign in to the system.

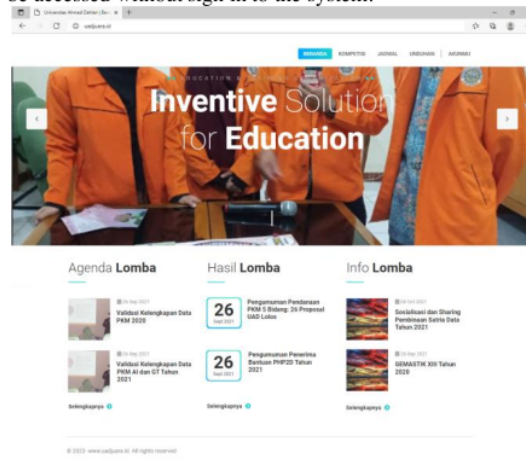


Fig. 3 Home Page UAD Juara

The login page would accommodate the user and the manager for the initial management process of establishing the student group. The login page also accommodated the user to create new accounts or recover registered accounts. The account registration and recovery mechanism require the official email of Universitas Ahmad Dahlan.

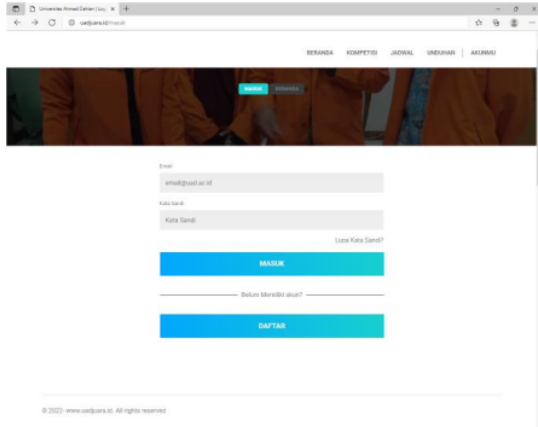


Fig. 4 Login Page UAD Juara

The user identity page would accommodate management process of each user's competency data. The form of user competence was interest in the involvement in competitions, awards and activities that had been achieved.

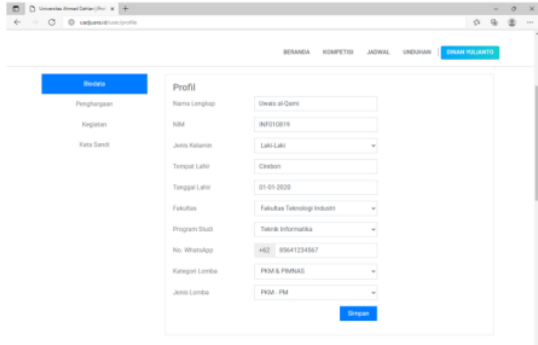


Fig. 5 User Identity Page UAD Juara

The user page would accommodate the management process for the preparation of the student group. The initial mechanism of group preparation was done by searching and viewing the details of other users' information. Each user could identify the identity data of other users who had competence to the competition topic specifically.

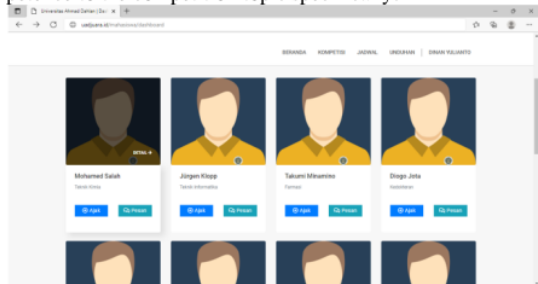


Fig. 6 User Page UAD Juara

The user identity details page would display the competency information details of one of the selected users to identify. All the displayed data was the result of the user identity management process (Fig. 4). Each user could identify and/or decide for the preparation of groups based on the compe-

tencies needed for the suitability of the interest of the competition and the proposed topic of the competition.

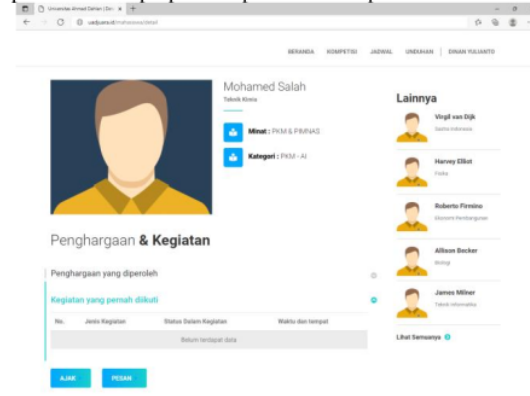


Fig. 7 User Identity Details Page UAD Juara

The invitation page would accommodate the main process of preparing student groups. Each user could apply for a group after identifying competencies from other user cooperation.

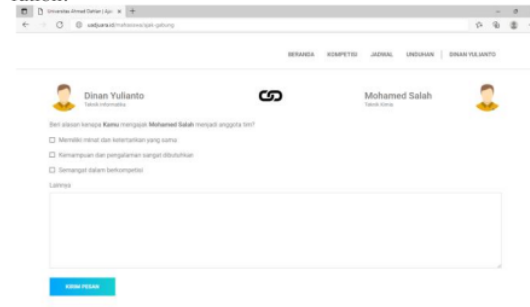


Fig. 8 Invitation Page UAD Juara

The discussion page would accommodate the discussion process between users related to the initial process of preparing the group and/or the coordinating process of the implementation of student group activities. The process of discussion and coordination could be done by text and attached supporting documents.

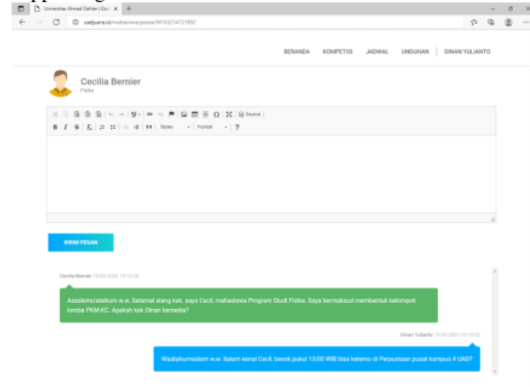


Fig. 9 Discussion Page UAD Juara

The whole process of obtaining information and forming student groups could be seen and managed by the system manager. The system design would accommodate all activi-

ties from users and managers side based on the results of the Use Case Diagram (Fig.2).

The result of the evaluate the design against the requirements sta⁸ was testing the system design by 30 respondents using the System Usability Scale and User Experience Questionnaire. The research respondents were students of the Dynamic Web Programming class consisting of 13 female and 17 male students. The students were in the 3rd year of college, and had competencies as business analysts in compiling business requirements documents, had competencies

as programmers in compiling website-based systems and had competencies as testers in testing website-based systems.

The testing process was carried out by gathering all respondents in an online meeting to present the results of the system design and deliver the test instrument. Later, a discussion related to the results and further development of the system design was carried out. The result of the respondents' interpretation through the SUS approach is illustrated in Table I and the UEQ approach is illustrated in Table II.

TABLE I
INTERPRETATION RESULTS OF SUS TEST

Respondent	Score										Sum Score *2.5
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	
1	3	3	3	4	4	3	4	3	3	3	82.50
2	3	3	4	3	4	3	4	4	3	3	85.00
3	3	4	4	3	3	3	4	3	3	3	82.50
4	2	3	3	3	4	3	3	3	3	3	75.00
5	3	3	3	3	4	3	4	3	4	2	80.00
6	4	3	4	2	4	2	4	4	3	3	82.50
7	3	3	3	3	3	3	3	3	3	3	75.00
8	3	3	3	3	4	3	4	3	4	3	82.50
9	4	3	4	3	3	3	3	4	3	3	82.50
10	4	2	4	2	4	2	4	2	2	2	70.00
11	4	3	3	3	4	3	3	3	4	3	82.50
12	3	3	3	3	3	3	3	3	3	3	75.00
13	4	3	4	3	4	3	4	3	4	2	85.00
14	4	3	4	2	3	3	4	2	3	2	75.00
15	3	3	3	3	3	3	3	3	3	3	75.00
16	3	3	4	3	4	3	3	3	4	3	82.50
17	3	1	4	3	4	3	4	3	4	3	80.00
18	4	3	3	4	3	3	4	3	3	4	85.00
19	3	3	4	3	4	3	3	3	4	3	82.50
20	4	3	4	2	3	3	3	3	4	2	77.50
21	4	3	4	2	4	3	3	2	4	2	77.50
22	3	4	3	4	2	4	2	4	3	3	80.00
23	3	2	4	4	3	4	3	4	3	2	80.00
24	3	3	3	3	4	4	3	4	4	3	85.00
25	3	4	3	4	3	4	3	4	3	4	87.50
26	3	3	4	2	3	3	4	3	4	2	77.50
27	3	3	4	3	3	3	3	3	4	2	77.50
28	3	4	3	4	3	3	3	3	3	3	80.00
29	4	3	3	3	4	4	3	3	3	3	82.50
30	3	2	3	4	3	2	4	3	3	3	75
SUS Score (Average)											80.00

* Informations: Q = Questions, 1...10 = number of questions

TABLE II
INTERPRETATION RESULTS OF UEQ TEST

UEQ Scales (Mean and Variance)		
Attractiveness	1.922	0.61
Perspicuity	2.158	0.51
Efficiency	2.042	0.47
Dependability	1.708	0.48
Stimulation	1.967	0.62
Novelty	1.917	0.38

The entire testing process indicates that the results of the prototype design have a good acceptance based on the average of SUS score of 80, and UEQ score on all variables that are positive and above the impression score of 0.8. The entire testing process is able to become an indicator of positive acceptance by users of the system being built and

become a recommendation in optimizing the end result of the sys⁵. An iterative testing also has to be carried out to ensure that the system development meets the needs and acceptance of users optimally.

IV. CONCLUSIONS

The output of this research is an interaction design and high-fidelity prototype of an information system and management of a student competition group. The system accommodates all user needs based on the categories of managers and end-users of the system. The design approach used in this study was User-Centered Design (UCD). The results of high-fidelity prototype testing using the SUS and UEQ approaches indicate that the interaction design and system interface achieve the usability and user experience goals. The result of the average SUS score of 80 has a level of acceptability ranges

2

in the “acceptable” category, a grade scale level in the “B” category, and an adjective rating level in the “excellent” category. The results of UEQ testing also confirm that the system has excellent “clarity” and “efficiency” variables.

Although the interaction and interface design of this application achieve the objectives of usability and user experience, several assessment variables need to be optimized in future work. Feed-back submitted by the respondents related to the assessment variable “accuracy” for future work is an adjustment of the user identity form with the competition guide book and functional updates on downloading the discussion activity as a competition logbook.

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APPENDIX

TABLE III
IDENTIFICATION RESULT OF USER & SYSTEM FUNCTIONAL REQUIREMENTS

No.	User Needs	Functional Requirements
1	Users can create new accounts	The system must accommodate account registration
		The system must validate account registration data
		The system must display the results of registration validation
		The system must display the user page
2	Users can recovery accounts	The system must validate registration email data
		The system must accommodate password restoration

No.	User Needs	Functional Requirements
		The system must save password restoration data
		The system should display the result of password restoration validation
3	Users can complete personal identity data	The system must validate the completeness of the user identity data
		The system must store user identity data
		The system must change the user identity data
		The system must display the results of the validation of the completeness of the user's identity
		The system must display detailed user identity information
4	Users can enter the system	The system must authenticate user account data
		The system must display the results of user account data authentication
		The system must direct account restoration against invalid user account data authentication
		The system must display the user page
5	Users can create competition groups	The system must display all user data
		The system must accommodate the filtering of user data
		The system must display the details of the users' identity data
		The system must provide recommendations for potential members of the competition group
		The system must accommodate the composition of the competition groups
		The system must display the results of the establishment of competition groups
		The system must accommodate data deletion of the result of competition group establishment
6	Users can send discussion messages	The system must display all user data
		The system must accommodate sending and receiving of text messages
		The system must accommodate sending and receiving of documents
		The system must display the information of discussion message receipt
		The system must display the details of discussion activity
7	Users can access information on guidelines, agendas, and competition results	The system must accommodate deletion of discussion messages
		The system must display the competition information articles by text and graphics
		The system must display categories of competition information articles according to the same characteristics
		The system must recommend similar competition information articles
8	Users can access coaching schedule	The system must accommodate searching for competition information articles
		The system must display coaching schedule information by text and graphics
		The system must display categories of coaching schedules according to the competition activities
9	Users can download documents	The system must display PDF documents
		The system must display detail information of all PDF documents
		The system must display the categories information of all PDF documents
		The system must display the number of attached PDF documents
		The system must accommodate searching for PDF documents
10	System manager can manage user data	The system must display all users by faculty and study program category
		The system must accommodate adding new user account data
		The system must accommodate searching for user account data
		The system must accommodate changes and deletions of user account data
11	System manager can manage faculty and study program data	The system must display all data of faculty and study program
		The system must accommodate adding faculty and study program data
		The system must accommodate searching for faculty and study program data
		The system must accommodate changes and deletions of faculty and study program data
12	System manager can manage data of competition groups	The system must display all establishment activities of competition group
		The system must display the status of the establishment activities of competition group
		The system must accommodate searching for competition group data
		The system must accommodate changes and deletions of competition group data
13	System manager can manage guidelines articles, agendas, and competition results	The system must accommodate the publication of competition information articles by text and graphics
		The system must accommodate categorization of competition information articles

No.	User Needs	Functional Requirements
		The system must display all competition information article The system must accommodate searching for article data The system must accommodate changes and deletions of competition information articles
14	System manager can manage competition coaching schedule	The system must accommodate the preparation of competition coaching schedule The system must display information on the results of the preparation of competition coaching schedule The system must accommodate searching for competition coaching schedule data The system must accommodate changes and deletions of competition coaching schedule
15	System manager can upload documents	The system must accommodate uploading process and description all PDF documents The system must accommodate categorization of PDF documents The system must display all uploaded documents The system must accommodate searching for PDF documents The system must accommodate changes and deletions of uploaded document data

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