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Design And Development of Android Application for Daily Construction Labor Mandor's with HCD (Human Centered Design) Approach

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Abstract: The construction industry is a development sector in Indonesia with a constantly increasing number of projects annually. In the projects, there is usually a construction manager (or 'mandor', in Indonesian) in charge of coordinating daily laborers and responsible for the construction's progress & financial report. These tasks often had problems, such as bookkeeping or managing construction workers. This research aims to develop an Android application for bookkeeping construction projects as a solution for construction managers to manage personal and non-personal resources. The development of this application uses an HCD (Human Centered Design) approach, which consists of 5 steps: user requirements gathering, problem grouping, designing, developing, and testing. The application is tested using the Blackbox and UAT (User Acceptance Test) method, gaining a 91.03% approval response. The research successfully provides an Android-based application that fulfills the needs of construction managers to work efficiently in managing personal and non-personal resources of the construction project.

Keywords: Construction, Manager, Bookkeeping, Android, Human Centered Design

1. Introduction

The development in Indonesia has increased rapidly from year to year, especially in the construction and infrastructure sectors. However, the COVID-19 pandemic has resulted in a decline in the number of micro, small, and medium-sized enterprises (MSMEs) in the construction sector, however, the number of projects continues to increase [1]. Executing construction development involves various parties, such as construction owners, contractors, and workers. These parties have high expectations for the role and function of a construction manager or "mandor". The construction manager's duties include recruiting, setting schedules, overseeing, training, monitoring, and paying construction workers' salaries. In addition, the construction manager also reports the progress of work and the required materials to the construction owner [2].

However, executing the construction manager's functions often needs to be addressed, which sometimes hinders the construction manager because of the manual bookkeeping. In general, the manual recording system increases the likelihood of human error. One way to minimize this error is by digitizing the systems, such as designing an application to facilitate the manager's tasks. The use of information technology has made management easier in various companies, including the construction sector, thereby improving efficiency and productivity [3]. Digitalizing various aspects

of life is an inevitable impact of the rapid development of information technology, especially with smartphones. The number of smartphone users in Indonesia continues to increase yearly, with 67.1% of the population in Indonesia, or 183.68 million people using smartphones in 2020. It is predicted to increase to 238.79 million people in 2026 [4].

On the other hand, smartphone users with the Android operating system dominate the market in Indonesia, accounting for 91.53% of users in 2019. Companies, including those in the construction sector, should use applications to facilitate management and improve efficiency and productivity. Along with the increasing demand for construction workers, the need for construction management bookkeeping is also increasing. Implementing an application shows that information technology in a mobile application can significantly help companies. Based on the above problem description, research to develop an application to facilitate the manager's work will improve the quality of the manager's work in construction projects.

2. Materials and Methods

2.1 Android

Android is an operating system used in several mobile devices today. Android is run using a multiuser Linux system, meaning that each application and its storage run under a different user, so the application cannot read other application data or internal storage under normal circumstances. For the version of Android itself, there are dozens of versions with a total of 17 codenames. These versions started with the earliest release on 23rd September 2008. According to James Stevenson (2021), in his book entitled "Android Software Internals Quick Reference: A Field Manual and Security Reference Guide to Java-based Android Components," in 2016, there were more than 5 million Android application developers. Then in 2019, there were 2.5 billion Android devices on the market, so Android is an operating system that is often used and will continue to grow [5].

2.2 Construction Manager (Mandor)

Construction Manager (or 'mandor', in Indonesian) is a position someone holds in a construction project, especially in Indonesia. The construction manager is in charge of construction workers in a project and bridging their relationship with management. The construction manager is expected to be able to manage labor and work at the operational level, such as increasing productivity, safety and quality of construction, and the performance of workers [6].

2.3 Human Centered Design (HCD)

HCD originated from Human-Computer Interaction (HCI), which considers the human factor in running computer systems and has also become a discipline in design. Donald Norman, a US researcher, became one of the best promoters of HCD, where he recognized the need for direct observation of activities and distinguishing between logic and usability [7].

Standardization of the use of HCD in developing interactive systems is currently documented in ISO 9241-210. The steps in designing using the HCD approach can be seen as in Fig.1. HCD start with planning the process, understanding and determining usability, determining user needs, designing solutions for user needs, then evaluating the design. If the evaluation results show that the user's needs have been met, then the HCD process is considered complete. However, if the evaluation results find that the user's needs have not been met, then these processes can be iterated according to the process requirements [8].

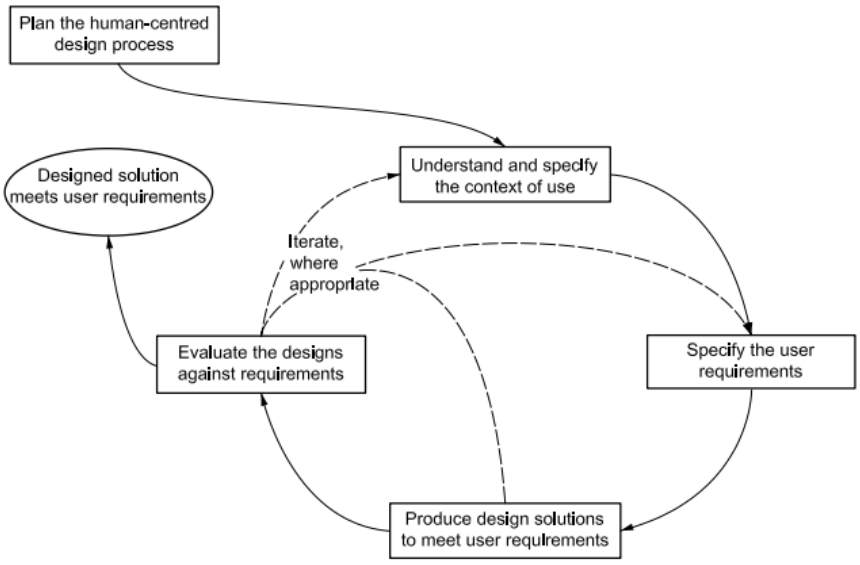


Figure 1. Interdependence of human-centred design activities

2.4 User Acceptance Test (UAT)

User Acceptance Test is a software testing method to determine whether the solution presented can be used and meets user needs. Testing is said to be successful if it meets the criteria. Ideally, the criteria should match what the user thinks the system should do. However, UAT should only be validated against predefined acceptance criteria, not against what users want from the new system. UAT verifies that the newly developed system includes all the required functionality [9].

The list of UAT questions used in this research is as follow:

1. Effectiveness
   a. Menu options in the application according to needs (UAT01)
   b. Appearance of information on the application is as needed (UAT02)
   c. This application makes it easy to calculate labor salaries (UAT03)
   d. This application facilitates the accounting of personnel and non-personnel (UAT04)
   e. This application helps project supervision in terms of financial resources (UAT05)

2. Effeciency
   a. Display menus on the application can be understood (UAT06)
   b. The menu provided makes it easier to use the application (UAT07)
   c. The response from the application does not feel long (UAT08)
   d. This app store up-to-date data (UAT09)

3. Appreciation
   a. Easy application system flow (UAT10)
   b. Will continue to utilize the application in the future (UAT11)
   c. Will recommend the app to others in the same scope (UAT12)
   d. Helpful app overall (UAT13)

3. Results

MandorApp aims to facilitate and expedite the development foreman in filling out attendance and bookkeeping for the entire project. This thesis produces an Android-based mobile application

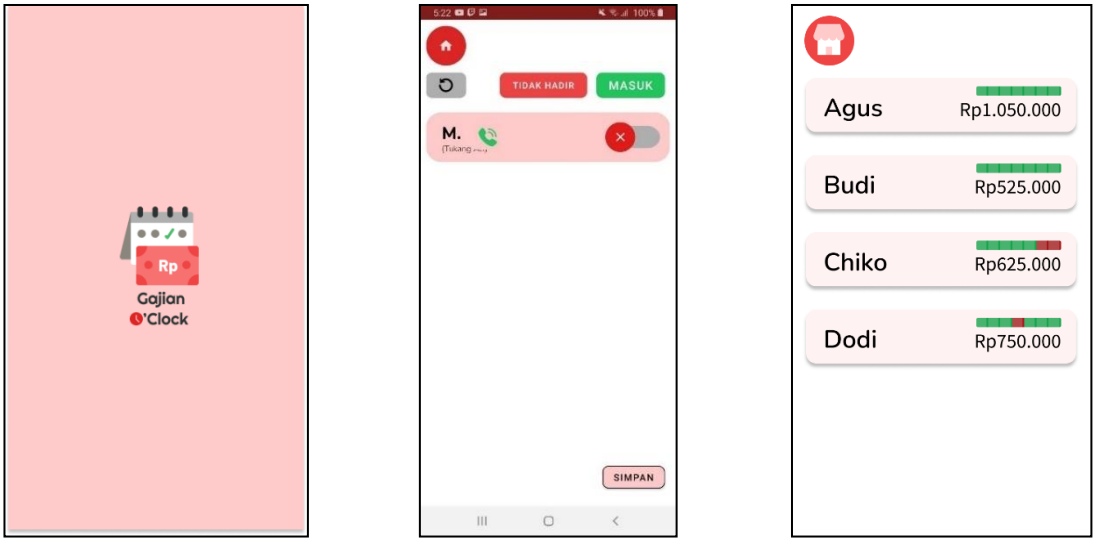
that can provide digital bookkeeping on the manager's smartphone, which helps facilitate the bookkeeping of the entire project from a personnel and non-personnel perspective.

3.1. Development

The MandorApp application development process goes through five iteration processes that are carried out to achieve the final result according to user needs.

3.1.1. First Iteration

The first iteration was carried out at the beginning of development, where changes were made in terms of appearance and application. Initially, the application development referred to the prototype. After receiving input from the user, changes were made in terms of functionality and appearance. Data storage is changed so that the application can calculate salaries simultaneously for each worker and is stored in a local database.



(a) (b) (c)

Figure 2. App layout design after first iteration of the application development: (**a**) SplashScreen page consisting of app logo and name; (**b**) Construction worker's attendance page; (**c**) Construction worker's weekly payrolls information

3.1.2 Second Iteration

In the second iteration, the logo and name of the application were changed from previously GajianApp to MandorApp, because the application does not only focus on the payroll of workers but aspects related to the foreman as well. In terms of appearance, changes were made by adding several buttons and displaying information in the form of page titles and dates on each available page.

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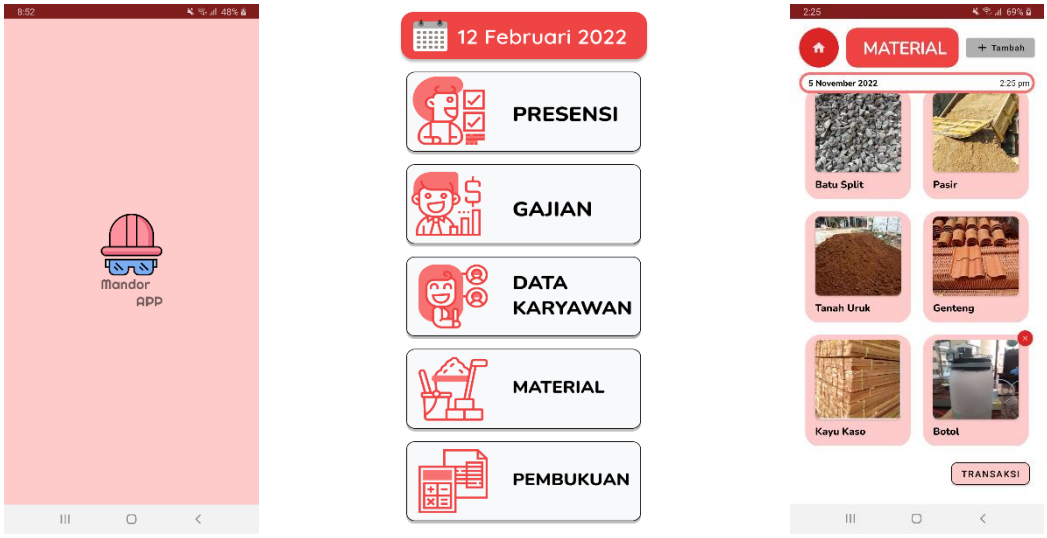
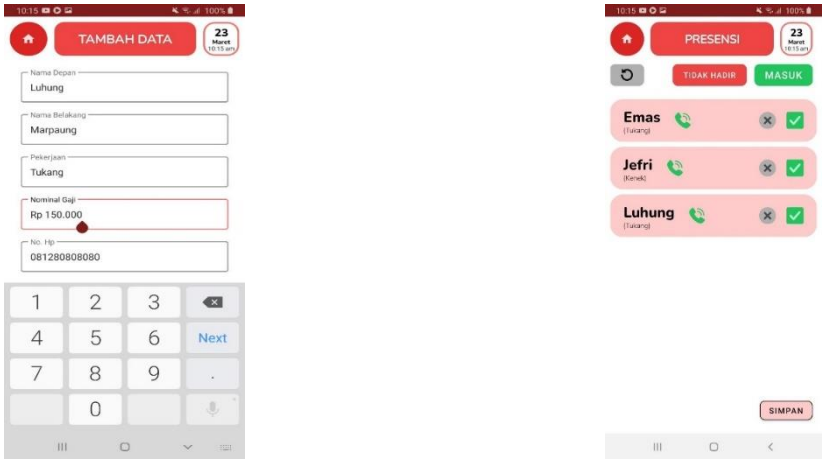


(a) (b) (c)

Figure 3. App layout design after second iteration of the application development: (**a**) Splash Screen page consisting of new app logo and name; (**b**) Application's main menu page; (**c**) Building materials listing page

3.1.3 Third Iteration

The third iteration of the application a function was added to convert numbers into currency units to make it easier for users to read. The display of numbers in the nominal salary section will automatically add points to adjust the input from the user. Several bug fixes were also carried out. These changes can be seen in Fig. 3.



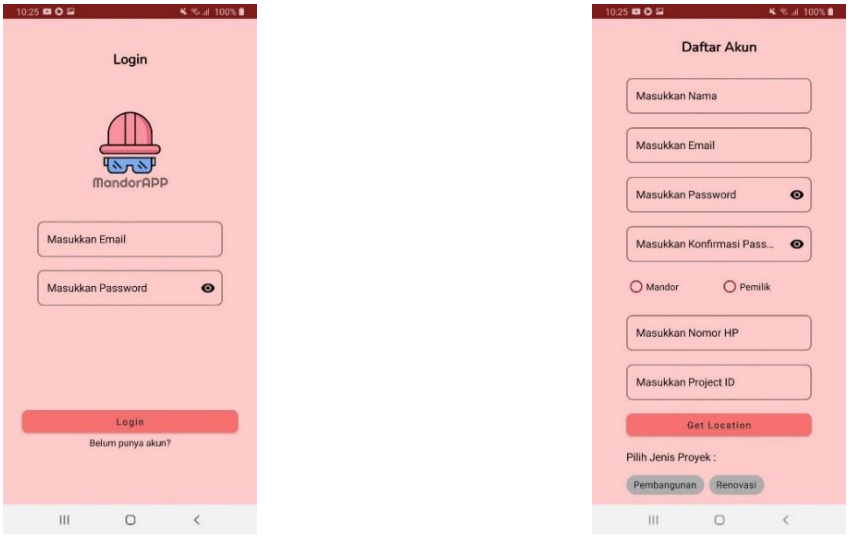
(a) (b)

Figure 4. App layout design after third iteration of the application development: (**a**) Number conversion function when inputting salary; (**b**) Attendance switch changed into button;

3.1.4 Fourth Iteration

The fourth iteration is carried out by adding register and login pages to the application so that the user can have the role of manager or owner when using the application. The application is still focused on the needs of the construction manager's perspective. However, the project owner can also see the reports, which is expected to make planning and monitoring project finances easier. Users can

also enter details of the project while registering an account. The appearance of the two pages is shown in Fig. 4.

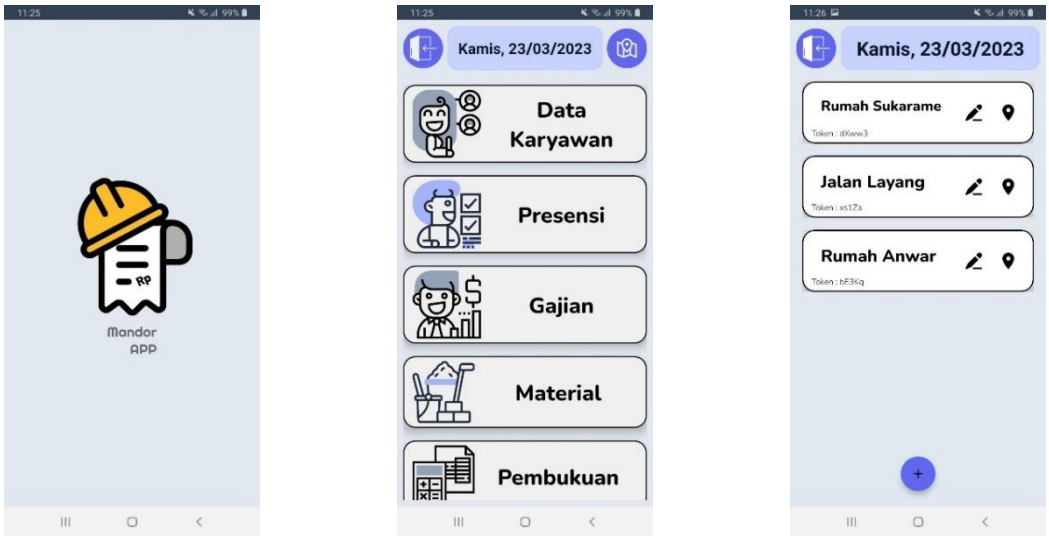


(a) (b)

Figure 5. App layout design after fourth iteration of the application development: (**a**) Login Page; (**b**) Registration page;

3.1.5 Fifth Iteration

In the fifth iteration, the application is connected to the API (Application Programming Interface) so that the application can be connected via the Internet. The API allows applications to be used on different devices with the same data. Project features is also added to separate and update project information in this iteration. Changes to the color and application logo have also been made. Previously dominated by red, the application's color has been changed to blue and white.



(a) (b) (c)

Figure 6. App layout design after fifth iteration of the application development: (**a**) SplashScreen page consisting of new recolored app logo and name; (**b**) Application's recolored main menu page with latest features; (**c**) Project list page.

3.2 Testing

UAT is done to determine whether the application meets the user's needs. Tests were carried out on six users who work as foremen, chief builders, or builders with 13 questions. As for the assessment results obtained from the effectiveness questions, namely 36.67% strongly agree, 53.33% agree, 10% disagree, and 0% strongly disagree, so it can be said that 90% of users agree, can be seen Fig. 7:

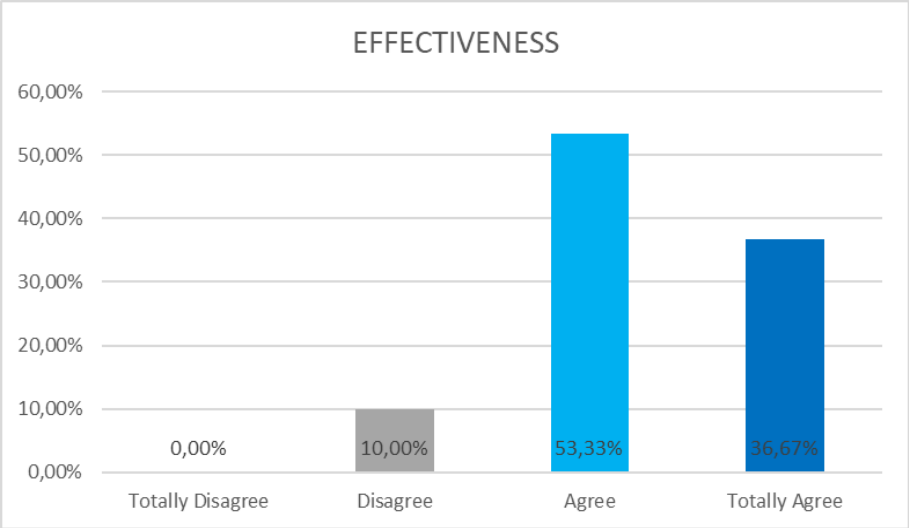


Figure 7. Bar chart showing UAT result from effectiveness category.

The assessment results obtained from the efficiency question were 50% strongly agree, 37.5% agree, 12.5% disagree, and 0% strongly disagree, so it can be said that 87.5% of users agree, as can be seen in Fig. 8:

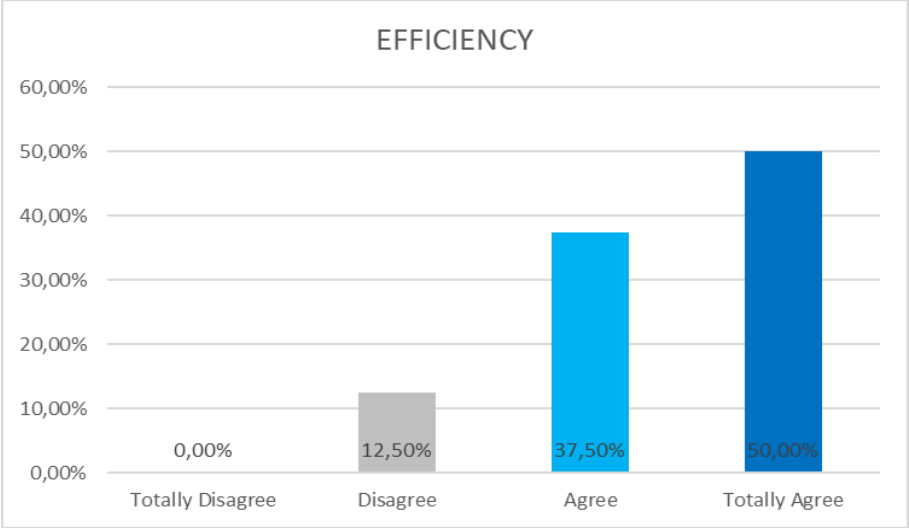


Figure 8. Bar chart showing UAT result from efficiency category.

Meanwhile, for the evaluation results of the appreciation questions, 45.83% strongly agreed, 50% agreed, 4.17% disagreed, and 0% strongly disagreed, so it can be said that 95.84% of users agreed, as can be seen in the following graph:

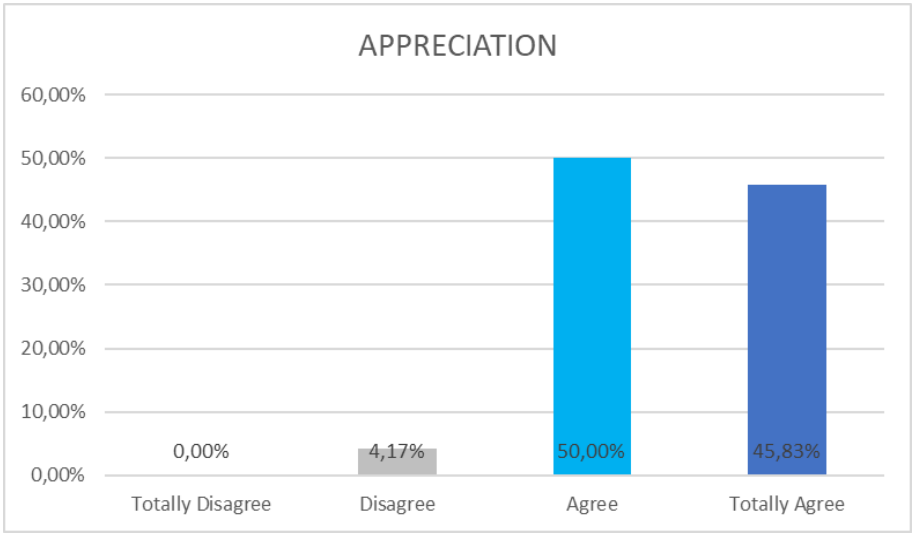


Figure 9. Bar chart showing UAT result from appreciation category.

From the UAT results, the highest score was agreed with 47.44% of the total response with 37 responses. The second highest was strongly agreeing with 34 responses, namely 43.59% of the total responses. For a value of disagree, get a value of 8.97% of the total response, namely seven responses. Meanwhile, they have yet to get a response or 0% of the total response for strongly disagree. Based on Table 1, it is known that the approval response received a value of 91.03%.

Table 1. UAT results from six respondents

Criteria	Score				Score
	1	2	3	4	
Effectiveness	0	3	16	11	30
Efficiency	0	3	9	12	24
Appreciation	0	1	12	11	24
Total	0	7	37	34	78

4. Discussion

During the research and development of MandorApp, an application designed to assist construction managers in fulfilling their responsibilities, determining the target user is gained by field observation in various construction sites. Because of using usability testing, which focuses on gaining user satisfaction, only six respondents of construction managers were gathered and questioned to represent and determine the user needs and requirements in helping to carry out their responsibilities.

However, most respondents need a clear vision of how to digitize what they have been doing daily to increase effectiveness and efficiency. Thus, developers need to show what a digitized method of work could do and give some insights on why it would make things easier. Working on a prototype of the current needs would boost and open up new insights from the user on how to develop the application.

By using HCD, this research has gone through five iterations based on user evaluation, and each iteration is developed separately after prototyping and development of the application process. By doing so, the research can focus on user needs based on their updated concerns. This method has also helped direct the development process, so it only widens the scope and area a little from the initial target.

Further research and development of the application can be towards maximizing the data stored in the application. Implementing and utilizing analytical tools within the app can be beneficial for decision-making within the scope of the construction project itself. The app can also be implemented in other fields of interest requiring daily workers, such as events, manufacturing, education, etc.

5. Conclusions

In conclusion, the HCD (Human Centered Design) method used in this study is suitable for designing and building the MandorApp application, with five development iterations, as it fulfills the user's needs. It can be shown that the users are satisfied with how the application works.

Based on the tests that have been carried out, it is found that the features contained in the MandorApp application run according to the testing scenario. The UAT shows that the results obtained from the MandorApp application are satisfactory for users, with 91.03% approval responses. The highest score was agreed with 47.44% of the total response with 37 responses. The second highest was strongly agreeing with 34 responses, 43.59% of the total responses on all three categories effectivity, efficiency, and appreciation.

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