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K-On Application Concept Design (K3 Oriented and Implementation using Participatory Design and Usability Testing Methods

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ABSTRACT

Indonesia as a developing country has become a country with a systematic infrastructure focus, with constant infrastructure growth making Indonesia a development country. Infrastructure, especially in the context of building or construction, has a linear relationship with the condition of construction workers, where construction workers are one of the main driving forces in the sustainability of development in Indonesia. However, the central role of this worker is not always followed by the worker's obedience to the applicable regulations in this case K3 construction. Work accidents in the construction sector increase every year, recorded as many as 114,148 throughout 2018 although it decreased to 77,295 cases in 2019, not diminishing the indication that construction workers should receive special treatment to reduce the number of work accidents. The development of technology is the basis for thinking for innovation in making platforms to cover almost every aspect of life, so the implementation of technology in an effort to provide special education to construction workers is expected to be optimal. The design of this concept uses participatory design and usability testing, to involve workers and stakeholders directly in the design process. The output of this research is an application concept design along with the percentage of effectiveness and efficiency that has gone through a pilot test process to end users, in this case construction workers and other stakeholders.

Keywords: ***Worker, Construction, Participatory Design, Usability Testing***

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I. PENDAHULUAN

Construction projects are a dynamic and risky field. This risk can have an impact on performance, quality, cost limits in projects and also work accidents, (Labombang, 2011) with construction workers being a special concern for implementing K3. Definition of occupational safety and health according to the Decree of the Minister of Manpower of the Republic of Indonesia. No. Kep. 463/MEN/1993 is that occupational safety and health is a protection effort aimed at ensuring that workers and other people in the workplace/company are always safe and healthy, and so that every production source can be used safely and efficiently. Meanwhile, the definition of occupational safety and health according to Edwin B. Flippo (1995) in (Satriawan, 2009), with increasingly rapid technological developments, the implementation of education regarding K3 for construction workers can be done through an application platform. storage will be full resulting in no room for other products.

The platform where information is most widely used today is the smartphone. In 2014 in the 4th quarter, based on data obtained from the Nielsen.com site, 77.8% were women and 76.3% men (The Nielsen, 2014)

The most interesting aspect of smartphones is the use of touch screen technology as the main input medium. The use of hands as a means of input is an attractive method for producing natural computer-human interactions (Wang & Ren, 2009)

The most direct interaction between humans and computers is the touch layer, where information and displays are on one surface (Albinson & Zhai, 2003)

To create a platform, an empirical approach is needed so that an application concept can be created, including Participatory Design and Usability Testing.

Participatory design is a cooperative approach involving various types of users in the design process. The goal is to ensure that the product is designed to suit its needs and use. Participatory design is an approach, which is focused on design processes and procedures and is not a design style (Sajja and Akerkar, 2012).

The methods commonly used in application development are the waterfall method, Rapid Application Development (RAD), and Participatory Design (PD), each development method has its own characteristics that suit the developer's needs (Sriyanto and Arvianto, 2018). This method will produce a concept that comes from stakeholders and usability testing will be carried out on the application mockup.

Usability is the main key to determining the success of an interactive system or product (Maguire, 2001)

Usability is defined as the level to which a product can be used by certain users to achieve certain goals effectively, efficiently and obtain satisfaction in the context of its use (Setia, 2015). Through testing methods, usability problems are found by observing users when using a system or product (Nielsen & Mack, 1994). Usability is closely related to the User Interface which consists of several components. These components are usually recognized as usability attributes. According to international standards issued by the International Body for Standardization (ISO) in ISO/IEC 205010 (2011), namely Functional suitability, Performance efficiency, Compatibility, Usability, Reliability, Security, Maintainability and Portability. Apart from that, in general there are 5 attributes in usability based on the Nielsen model, namely (Metara et al., 2005) in (Khoirina, 2017) learnability, efficiency, memorability, errors and satisfaction. In this case, effectiveness and efficiency are the benchmarks for carrying out usability testing. Usability is also known today as the main key that determines the success of a product through an interactive system (Maguire, 2001). There is a problem with the current usability method because it does not take into account the characteristics of devices with touch screens and physical interfaces. As one of these solutions, there have been proposals for 11 heuristics which are adaptations of usability principles in the context of touchscreen-based mobile evaluation (Inostroza et al, 2012). There are 3 methods that are most widely used for development in the phase of finding usability problems, namely Think-Aloud Evaluation (TA), Cognitive Walkthrough (CW) and Heuristic Evaluation (HE). To compare these three evaluation methods, several comparative measures are used, including validity, thoroughness, effectiveness and severity rating methods (Hartson et al, 2003). Based on research conducted (Hendradewa, 2017), the heuristic evaluation method obtained the best scores in almost all comparison measures, but in this research, Cognitive Walkthrough was used because it was still in the early stages of development.

1.2 LITERATUR REVIEW

A project is a collection of interconnected activities where there is a starting point and an end point as well as a specific outcome, a project usually requires a variety of skills from various professions and organization.According to Dipohusodo in 1955 in (Hafnidar, 2016), a project is an effort that mobilizes resources available, organized to achieve goals, objectives and certain important expectations and must be resolved within the term limited time according to agreement. A project is an activity carried out with resources and limited time to achieve the results that have been achieved determined.

In achieving the desired end result, activities projects are limited by budget, schedule and quality (Hafnidar, 2016). Projects (construction or other) according to Ahuja et al 1994 in (Utama, Asnudin and Labombang, 2013), is a unique action or job that

basically has one goal that has been determined field or field, quality or desired quality, time and price.

Based on the opinions of the experts above, it can be interpreted as a project Construction is a series of interrelated activities to achieve certain goals (building/construction) within limits certain time, cost and quality. Construction projects always require resources (resources), namely man (people), materials (building materials), machine (equipment), method (implementation method), money (money), information (information), and time (time) (A Rani, 2016). In research. Sometimes the discussion focuses on construction projects.

Occupational safety and health according to the Decree of the Minister of Manpower of the Republic of Indonesia. No. Kep. 463/MEN/1993 is that occupational safety and health is a protection effort aimed at ensuring that workers and other people in the workplace/company are always safe and healthy, and so that every production source can be used safely and efficiently. Meanwhile, the definition of occupational safety and health according to Edwin B. Flippo (1995) in (Satriawan, 2009), is an approach that determines comprehensive and (specific) standards, determines government policies on company practices in workplaces and implementation through summons letters. , fines and other penalties. So it can be concluded that occupational safety and health is one of the parts provide systematic steps to protect workers in carry out work to stay safe and healthy.

2. METHODOLOGY

The research methodology explains the steps that must be taken in this research to solve existing problems. These steps start from determining the research object, type and source of data and data collection techniques.

3.1 Time and Place of Research

This research was carried out for 2 months, this research was carried out at a construction project for the building of the Faculty of Medicine, Indonesian Muslim University.

1.2 Data collection

Secondary data in this research are:

1. Project work description
2. Number of workers
3. Worker demographics
4. Data on the level of usability of the design

1.3 Participatory Design Method

Participatory design itself is an antithesis to traditional designs where the designers of a product will show their work more. However, useful and precise information about user needs can be obtained by involving users in the product design process, which often cannot be provided by other methods such as interviews, observations or questionnaires (Reich et al., 1996). There are 3 methods in Participatory Design, namely STEPS, MUST, CESD. The following is a description of each method:

1. STEPS method
   This method combines software engineering with participatory design, with a focus on custom-based development and creating it from scratch.
2. MUST method
   This method involves all elements in software or application development, starting from stakeholders, management, to all staff involved in the process, so that software development does not only involve developers, but everyone in the company is involved in developing it.
3. CESD method
   This method requires looking for participants from experts in their fields such as advanced users, analysts, designers and programmers who are expected to be able to cooperate in creating a software system or application, so that the results of the development will produce software that truly meets expectations (Sriyanto and Arvianto, 2018).

From the three PD models, 1 method will be selected which is most suitable for use in this research. For comparison between the 3 development models described above, the STEPS method is most suitable for this research because the application development is custom and starts from scratch or can be said to be made from scratch.

1.4 Usability Testing

To carry out a usability test, an inspection method is needed so that the system that has been designed is on target using Cognitive Walkthrough.

Cognitive Walkthrough is an inspection method that focuses on the ease of a design to be studied through walkthrough (Wharton et al, 1994). The output of the Cognitive Walkthrough method is a record of problems and potential usability problems at certain stages in the user interaction cycle (Jaspers, 2009).

In (Aprilia et al, 2015) stated that usability measures must include three aspects, as follows:

a. Effectiveness
   Effectiveness indicates the level of accuracy and perfection a user achieves when performing a specific task. Which can be tested in the design process.
b. Efficiency
   Efficiency shows the resources used in relation to the accuracy and perfection achieved by users in carrying out tasks.
c. Satisfaction
   Satisfaction shows that users feel free from discomfort and show positive behavior towards using the product.

According to (Yulianto et al, 2015), the level of effectiveness and efficiency is measured using the user's success rate. The equation formula for calculating effectiveness and efficiency is as follows:

1. Effectiveness, efficiency (%) = $\frac{\sum_{i=1}^{n} Xi}{n} \times 100\%$ …….(1)
   Where Xi is the success value of the ith respondent, Xi = {0.1}, n = number of respondents. Then the equation formula for calculating the level of satisfaction is as follows:
2. Satisfaction (%) = $\frac{\sum_{i=1}^{n} Xi}{n} \times 100\%$ ……..……(2)
   Where Xi is the success value of the ith respondent, Xi = {0.1}, n = number of respondents Application usability is the average of effectiveness, efficiency and satisfaction, as written in the following equation:
3. Usability (%) = $\frac{(Efektivitas\ (\%) + Efisiensi(\%) + Kepuasan(\%))}{3}$
   The final value of usability is used to evaluate the value of effectiveness, efficiency and user satisfaction with the application design.
   According to (Wasilah, 2012) calculating the percentage can be calculated using the following formula:
4. Percentage (%) = $\frac{n\ (jumlah\ yang\ diperoleh)}{N\ (Jumlah\ keseluruhan)} 100\%$
   There are 9 methods for usability testing, performance measurement is used more in this research. Respondents were divided into 3, namely novice users, knowledgeable intermittent users and expert users.
   Based on the first data collection for the number of workers and respondent demographics, there are several stages in selecting respondents for each activity, namely distribution of demographic questionnaires, determination of participatory design respondents, performance measurement and SUS respondents which can be seen in the following table:

Table 1. Recapitulation of Respondent Selection

Activity	Amount	Information
Distribution of demographic questionnaires	42 person	- 33 people succeeded - 9 people failed
Participatory design needs (end user)	3 person	-
Determination of SUS respondents	33 person	- 30 people succeeded
Determination of performance measurement respondents	10 person	- 20 people didn't make it

From the questionnaire that had been distributed to respondents, 42 respondents were found to have filled out the questionnaire. Of the 33 respondents, 30 of them met the criteria or matched the characteristics of the research needs.

The respondents needed for the next stage (Pilot Test) are 2 people, for Performance Measurement 10 people. The following is a data table of respondent characteristics

3. RESULT AND DISCUSSION

3.1 *Participatory Design*

3.1.1 Determining Application Features and Design (Participatory Design)

In the design process with Participatory Design using the STEPS method, there were several inputs provided by participants, including experts in the construction sector, UI designers & software engineers and also several other respondents. For suggestions and input, see Table 9 below.

Table 2. Result Participatory Design

Stakeholders	**Problem**	**Repair**
Head of Construction	There are still many workers who are slow to understand. Workers tend to work randomly	The design is made as simple as possible Create a special team job description checklist feature and also real-time updates of the job
Designer UI & Software Engineer	The suggested design is simple but can reduce the aesthetic value of the application itself	Create a game of color so that the application is eye catching so it is good in terms of aesthetics
Construction K3 Actors	There are still some workers who still do not use the	Provides features that contain specific job

	right personal protective equipment	descriptions and K3 handling
	Some workers feel less than optimal at work when using personal protective equipment	Create a feature regarding education on the importance of wearing personal protective equipment in every work item
End User	Less interested (tends to get bored) if the application only displays text	The application is accompanied by pictorial explanations so that the application looks more lively and does not cause feelings of boredom

Of the 5 problems encountered during the PD process, the first step was to carry out design iterations to meet stakeholder needs and satisfaction. After design iterations are carried out, PD continues with Paper Prototyping design.

Based on the results of the participatory design, a decision was obtained regarding the features and functions of the application which took into account aspects of the application's user needs and segmentation when used. The following is a list of features and their functions that have been studied through participatory design:

Table 3. Application Features

No	Function	Features
1	Splash Screen	Home panel when the application is opened
2	Login and Signup	Panel for filling in username and password to carry out login activities, as well as account registration panel for initial registration before accessing the application
3	Home page	The main panel displays the overall features, both the main features and the navigation bar.
4	Job List	Contains job descriptions in an order to make it easier for workers to maximize their work.
5	List of PPE	Panel containing Personal Protective Equipment used in construction work with priority of use.
6	Timetable	Contains information regarding the continuity of the overall project work stages. Information is packaged densely with a percentage bar.
7	Work team	The panel contains information about work team members based on a specific work team.
8	K3 Awareness	This is the core of the application, which contains the entire job description along with the tools used, potential hazards and efforts to minimize hazards.
9	Report	Fill in the form panel to report work results directly to the project head for updates on construction progress.
10	Navigation Bar (Messages)	Panel for sending messages with work team members or with project management which is directly connected to the work team feature.
11	Navigation Bar (Notifications)	Supporting features that provide notifications to users for every activity carried out.
12	Navigation Bar (Profile)	Panel with appearance that can be personalized to make the identity look more professional. Equipped with information on the

		number of work items and sub-items that have been completed, as well as history records or activity logs during application use.
13	Navigation Bar (Settings)	Provides assistance for personalizing things in universal applications with several setting options, namely accounts, chat notifications, storage.

3.1.2 Paper Prototyping Application

After initial discussions have been carried out on the application by conducting Participatory Design, the next step will be to design the application using the Paper Prototyping method. Paper prototyping produces a mockup design with a woreframe appearance as in the image below:

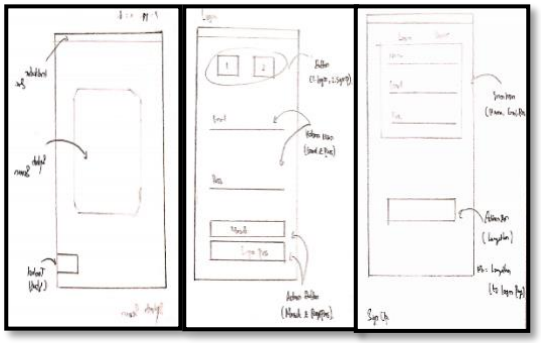

Figure 1. Paper Wireframe Design Results from Paper Prototyping

3.1.3 Making Application Prototype Design Mockups

The mockup was made after going through a participatory design process and carrying out paper prototyping. Making a design into digital form requires special attention to color selection, compatibility with the paper wireframe design and not going outside the application concept.

The results of this mockup design will then become a reference for developers to create application designs. This mockup design will be used as a medium for conducting pilot tests and measuring the System Usability Test. The following are the results of digitizing the paper wireframe application design using a simple UI design without adding aspects that do not match the concept.

Usability testing is carried out after the application prototype based on the mockup is completed.

Figure 2. App Mockup Design

3.2 Pilot Test

After carrying out the Participatory design stage, a pilot test was carried out to measure the effectiveness, efficiency and usability of the application design. The pilot test was carried out by 10 people and will go through 5 task scenarios that will be given. Measurements include effectiveness (how many respondents completed tasks and how many tasks were completed and efficiency (how long respondents took to complete tasks and how many tasks were completed outside the time limit).

3.3 Usability Testing

In testing the usability of the application mockup design using performance measurement, respondents were given 5 task scenarios that had to be implemented and completed. From these 5 tasks, the data that will be obtained is the level of success in completing the task and the duration of the respondent in completing the task which will later be an assessment of the level of effectiveness and efficiency.

a. Effectiveness

The effectiveness calculation is carried out based on the level of success of each respondent in completing the task. The level of success is seen from the number of tasks successfully completed from a total of 5 scenarios given. After the results are calculated using the effectiveness formula, they will be averaged over a number of respondents who took the test, namely 10 respondents, so that the calculation of respondent effectiveness can be known.

Based on data processing, it is known that of the 10 respondents who worked on the task scenario, 2 respondents succeeded in completing all the tasks given and the remaining respondents completed 4 tasks and failed in only 1 task. The

minimum percentage of effectiveness is 60% and compared to 100% respondent effectiveness, the average respondent effectiveness is 84%. For the effectiveness of tasks for respondents based on data processing, it can be seen that from the 5 task scenarios given to 10 respondents. Task 1 can be completed by all respondents, while task 2 can only be completed by 7 respondents. Tasks 3 and 5 were completed by 9 people each and only 1 person failed. Task 4 can be completed by 8 people and 2 people failed..

b. Efficiency

Mobile application efficiency calculations are carried out based on the duration of the respondent or participant in carrying out the task. The following is a table of respondent efficiency.

In data processing, it was seen that of the 10 respondents who had completed the test scenario, there were only 2 people who were able to make their tasks more efficient by 100% and 4 other respondents were able to make their tasks more efficient by more than 70% and 4 people were able to make their tasks more efficient at 60% of the time. which are given. The minimum percentage of respondent efficiency is 48% compared to the maximum respondent efficiency of 100, the average percentage of respondent efficiency is 77%. Next is to calculate the efficiency of each task given to the respondent.

Based on data processing, it can be seen that of the 5 task scenarios given to 10 respondents, task 1 could be completed by all respondents without exceeding the time, task 2 was successfully completed by 7 respondents, tasks 3 and 4 could be completed by 8 respondents and task 5 was only completed by 1 people who do tasks outside the time limit. Below is a graph of task efficiency. The minimum percentage of task effectiveness is 49% compared to the maximum effectiveness of 100%, resulting in an average task effectiveness of 74%.

3.4 System Usability Scale

After collecting the SUS questionnaire data, the next step is to carry out validity and reliability tests. Inputting validity and validity is done by dividing into 2 categories, namely odd questions and even questions, because odd and even are divided into expected and unexpected question items, therefore testing the validity and reliability of both are separated. After carrying out the test, data processing will be carried out.

Based on the results of the system usability scale score table above, the resulting satisfaction score is included in the excellent category because the average score obtained is 76 which is in the acceptable rankings adjective category so that this application is of good quality and quite satisfactory. Apart from that, the weight factor for usability in each SUS was also found in subjective assessment results which can be seen in the graph below.

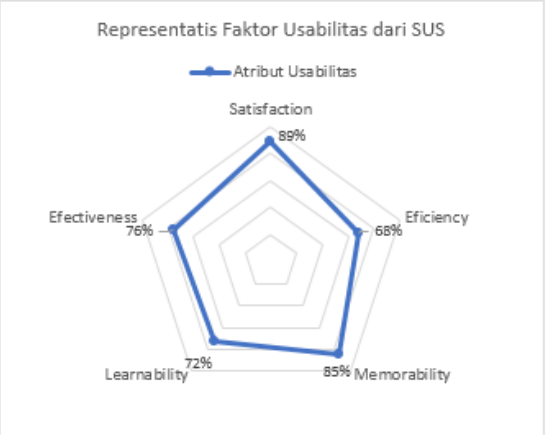

Figure 3. Representative Subjective Assessment of Application Concept Usability Factors

In the picture above, it is subjectively found that the application design capability has an advantage in the satisfaction factor, namely 89% and memorability of 85%, this shows that the application can provide a sense of satisfaction for users and is easy to remember. The application itself is quite effective with a percentage of 76% and easy to learn with a score of 72% and an efficiency of 68%.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

1. The level of effectiveness of respondents in carrying out tasks was 84% and task effectiveness was 86%, so the average effectiveness was 85%. The effectiveness level of respondents was 77% and task efficiency was 74%, so efficiency was 75.5%. Based on usability testing using the System Usability Scale (SUS), the application design results obtained had a weight score of 76% in the Excellent category.
2. Based on the test results, the application design is considered ready to be implemented in order to provide continuous education to construction workers about the importance of implementing K3 to reduce the number of work accidents.

4.2 Recommendations

From the conclusions above, there are several suggestions for using this application design optimally:

1. The developer provides a finishing touch to give a soft impression to the application and reduce the design which seems stiff.

2. Take structured and systematic steps if you want to add a feature or want to change the majority of the design that has gone through the design process and stages. If further research is carried out, it is recommended to use participatory ergonomics.

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