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Digital Measurement of the Construction Workers' Performance through the Five-Minute Rating Method

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ABSTRACT

The Five-Minute Rating method is a simplified approach used to measure workers' performance based on time study principles, aimed to provide representative evaluations with minimal observation samples. However, its adoption in the construction industry remains low at only 6.4%, due to perceived impracticality and time-consuming implementation. A digital solution known as the Five-Minute Rating Solver (FMR-Solver), developed as an Android-based application, has been introduced. However, the practicality of its use and the efficiency of the measurement duration have yet to be studied. This study aims to measure the efficiency of the application tool in assessing worker effectiveness compared to using the conventional Five-Minute Rating method and to evaluate users' perceptions of using the application. A case study was conducted during the installation of foundation reinforcement. The results show that the application tool can increase measurement efficiency by 22.6%. Evaluations by five users—based on criteria of stability, accuracy, understandability, operability, usefulness, and attractiveness—indicate validity scores ranging from 76.0% to 96.0%, falling within the categories of valid to very valid. The results suggest that the method offers a practical and effective alternative for construction workers' performance and holds promise for wider industry adoption.

Keywords: Digitalization; Efficiency; Five-Minute Rating; Labor Performance

ABSTRAK

Five-Minute Rating merupakan salah satu metode pengukuran efektivitas kinerja berdasarkan prinsip *time study* dan bertujuan untuk memberikan penilaian yang representatif dengan sampel pengamatan yang relatif kecil. Namun, penggunaannya di industri konstruksi cukup rendah yaitu hanya 6,4% dengan alasan bahwa metode tersebut tidak praktis dan tidak singkat. Saat ini, pengukuran dengan alat bantu aplikasi Android berbasis *Five-Minute Rating Solver* (FMR-Solver) mulai diperkenalkan. Akan tetapi, tingkat kepraktisan dalam penggunaan dan efisiensi durasi pengukuran belum dikaji lebih lanjut. Penelitian ini bertujuan mengukur efisiensi alat bantu aplikasi dalam menilai efektivitas pekerja dibandingkan menggunakan metode *Five-Minute Rating* secara konvensional dan menilai persepsi pengguna dalam menerapkan aplikasi tersebut di lapangan. Studi kasus dilakukan pada pekerjaan instalasi tulangan sloof. Hasil studi menunjukkan bahwa alat bantu aplikasi mampu meningkatkan efisiensi durasi pengukuran sebesar 22,6%. Penilaian lima pengguna aplikasi berdasarkan kriteria *stability, accurateness, understandability, operability, usefulness,* dan *attractiveness* mencapai nilai pada rentang 76,0%-96,0% dengan kategori valid dan sangat valid. Hasil penelitian ini diharapkan memberikan gambaran bagi kontraktor atas penggunaan metode yang praktis dalam mengukur kinerja pekerja konstruksi, terlebih setelah adanya digitalisasi.

Kata Kunci: Digitalisasi; Efisiensi; *Five-Minute Rating*; *Labor Performance*

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INTRODUCTION

Technological advancements are playing an increasingly important role in the construction industry. Among the advancements, digitized performance measurement tools have emerged to enhance worker performance. Various forms of performance measurement technology at the digitized construction operation level include Method Productivity Delay Model (Januardi et al., 2025), Crew Balance Chart (Aziz et al., 2024), and Five-Minute Rating (Rochman, 2024). These tools aim to streamline the evaluation process of worker productivity and effectiveness, rendering it more time-efficient and practical (Aziz, 2023). Despite this progress, the implementation of such methods remains limited. A survey by Ulhaq (2023) found that only 6.4% and 8.8% of 125 construction practitioners had applied the Five-Minute Rating and Work Sampling methods in their projects. The Indonesian construction industry should further explore the development of digitalization and the application of more technology (Soemardi et al., 2020). At the same time, the rise of mobile technologies has opened new possibilities for enhancing workplace efficiency, including in construction productivity measurement (Oesterreich & Teuteberg, 2016).

Productivity and effectiveness assessments are not the same. Construction operation productivity assessments provide an overview of the ability of individuals or work groups to complete construction components in specific units. This aligns with definitions provided by Pramesti and Priyanto (2023) and Waney et al. (2023), who conceptualize productivity as the ratio between input—commonly expressed in man-hours (MH) or man-days (MD)—and output, defined by the quantity of completed work units or work capacity over a specific time interval. Effectiveness is the alignment between previously set goals and objectives and the results achieved (Rahmadini et al., 2023). In contrast, effectiveness pertains to the degree to which actual outcomes align with predefined goals and objectives (Rahmadini et al., 2023). When low productivity is suspected to stem from labor-related factors, effectiveness assessment can serve as a practical preliminary diagnostic tool that offers insights into worker performance before undertaking more comprehensive and time-intensive productivity analyses.

One way to measure worker effectiveness is through Five-Minute Ratings. This method involves observing workers for five minutes per sample, and their activities are classified as either active or inactive. A worker is considered to be actively working if the total duration of work exceeds 50% during the observation period (Dozzi & AbouRizk, 1993). However, the method is generally limited to small-scale observations and is less effective when applied to larger workgroups.

Digitalization refers to the process of transforming conventional systems into digital ones through the integration of information and communication technology. This process aims to improve efficiency and innovation in various fields, including construction. In this context, platforms such as MIT App Inventor offer pathways for the implementation of digitalization (Loukatos et al., 2024). One such initiative is the digitization of the Five-Minute Rating method through the development of the *Five-Minute Rating Solver* (FMR-Solver), an application created using the open-source MIT App Inventor by Rochman (2024). However, the efficiency of the application compared to conventional measurements has not been assessed, including its practicality for use by other parties.

This study aims to evaluate the efficiency of the FMR-Solver in terms of measurement duration when assessing construction worker effectiveness, as compared to the traditional Five-Minute Rating method. In addition, the study investigates user perceptions of the application, focusing on six indicators, i.e., stability, accuracy, understandability, operability, usefulness, and attractiveness.

THEORETICAL FRAMEWORK

Five-Minute Rating

Yates (2014) explains that the Five-Minute Rating method is useful for identifying whether workers are engaged in productive activities or are idle. According to Dozzi and AbouRizk (1993), this method offers a snapshot of crew effectiveness in performing their tasks. Similarly, Oglesby et al. (1989) emphasize that the primary objective of the Five-Minute Rating is to evaluate worker effectiveness.

When compared to other commonly used methods such as work sampling and time study, the Five-Minute Rating stands out for its simplicity and speed in gathering data on worker conditions. Although it is not as precise as these more comprehensive techniques, it offers a practical alternative for quick assessments in the field (Farooq & Moon, 2019; Abukhalaf & Abusal, 2021).

Measurement Stages

Measuring effectiveness using Five-Minute Ratings involves three main stages (Yates, 2014):

1. The first stage is preparing a standardized assessment sheet. This sheet is formatted as a table where the columns represent individual personnel or worker identifiers, and the rows indicate specific observation time intervals. This format ensures systematic data recording during the observation process.

2. The second stage is observing workers' activities. In this stage, observers monitor worker activities at fixed intervals, typically every five minutes. Each observation captures whether a worker is actively engaged in productive tasks. If the duration of active work exceeds 50% of the observed interval, a checkmark (✓) or symbol such as "x" is entered in the corresponding cell of the assessment sheet to denote productive status. Observers may also include brief qualitative notes for activities that do not clearly fall within the "working" category.

3. The final stage involves determining the effectiveness level of individual workers or teams. This is calculated by dividing the number of "working" observations by the total number of observations. The result is expressed as a percentage to represent the proportion of time workers were observed performing productive activities during the assessment period.

Table 1. Five-Minute Rating Observation and Analysis Form

5 Minutes Rating — *Date: 8/1/2007*

Analysis Crew : Precast Panel Erection — *Page: 1 of 1*

Job : University Dormitory Structure

Time Interval : 1 Minute — ☐ *= Effective Work*

Weather : Sunny

Observ.	*Time of Observ*	*Man 1 Iron Worker*	*Man 2 Iron Worker*	*Man 3 Carpent.*	*Man 4 Carpent.*	*Man 5 Carpent.*	*Man 6 Welder*	*Operations*
1	10:13	☐						*Crew waiting for panel hosting*
2	:14	☐	☐	☐	☐	☐		*Landing panel/welder waiting to tack*
3	:15	☐	☐	☐	☐	☐		*Landing panel/welder waiting to tack*
4	:16		☐	☐	☐	☐		*Install upper brace bolt*
5	:17		☐		☐	☐		*Install bracket*
6	:18			☐	☐	☐		*Align panels*
7	:19			☐	☐	☐		*Align panels*
8	:20			☐	☐	☐		*Align panels*
9	:21	☐	☐	☐				*Unhook crane*
10	:22	☐	☐	☐				*Unhook crane*
11	:23						☐	*Welder tacks rebar, crew waits for*
12	:24						☐	*Next panel to be hoisted*
13	:25						☐	*" "*
								Total
	Maximum Total	***13***	***13***	***13***	***13***	***13***	***13***	***78***
	Effective Total	***5***	***6***	***8***	***7***	***7***	***3***	***36***
	Effectiveness Ratio	***38%***	***46%***	***62%***	***54%***	***54%***	***23%***	***46%***

Source: Yates (2014)

FMR-Solver Application

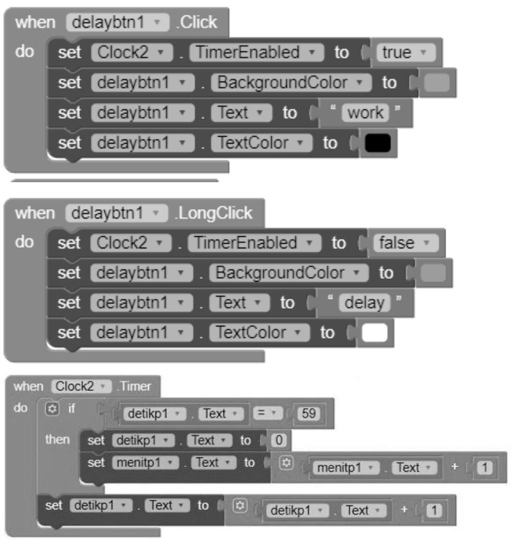

Figure 1. Coding Block Section of the Interface for Worker Condition Input

The FMR-Solver application is a product resulting from the digitization of the Five-Minute Rating measurement method developed by Rochman (2024) using the Android application development platform MIT (Massachusetts Institute of Technology) App Inventor. This platform is user-friendly for those without coding experience, as the application development process utilizes a drag-and-drop approach (Ulum & Badri, 2023) (Tombeng et al., 2023). Figure 1 illustrates the coding block design of the FMR-Solver.

The FMR-Solver facilitates the data collection and processing phases of worker effectiveness assessment by automating the classification of activities into "working" or "not working" categories. Unlike the manual method that requires observers to assess whether the duration of active work exceeds 50%, this application allows users to simply press a button to record whether a worker is engaged in productive activity. Based on these inputs, the application automatically calculates the effectiveness level. Figure 2 displays the initial user interface upon launching the application, where users are presented with a "Start" option to begin the assessment process.

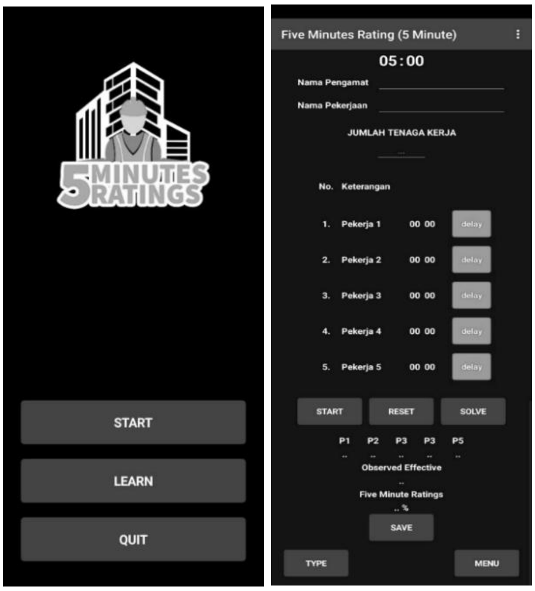

Figure 2. User Interface FMR-Solver

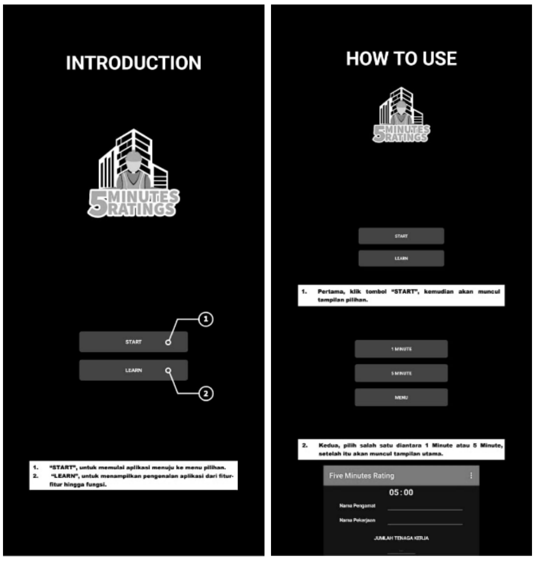

Figure 3. Interface of Introduction & Procedure to use FMR-Solver

The user interface of FMR-Solver is quite user-friendly because it provides a page to introduce and provide information on how to use this application. Figure 3 shows the interface when selecting the "learn" button.

METHODOLOGY

Research Design

This study was conducted by comparing the measurement of worker effectiveness using the FMR-Solver application with the conventional method, from the initial preparation of observations to obtaining the effectiveness results from the Five-Minute Rating method. A clearer description of each stage of the study is presented in Figure 4.

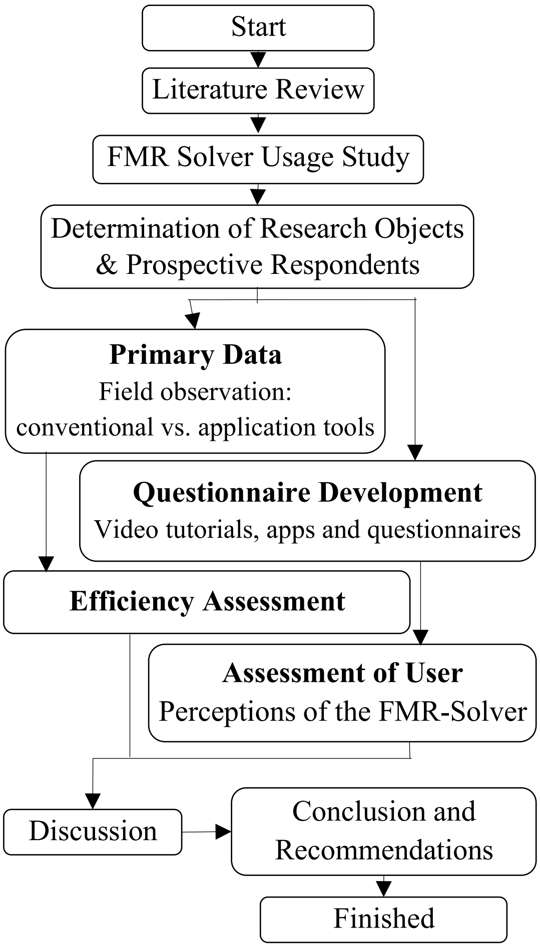

Figure 4. Research Flow

Effectiveness Measurement Techniques

The steps for using the FMR-Solver application are as follows (Rochman, 2024).

1. Click "Start" on the front screen.
2. Fill in the observer data and the work to be observed.
3. Click "Start" on the main screen when you are ready to observe the first sample work.
4. Observe the worker.

5. If the worker is not working, click "Delay," then if the worker starts working again, click and hold "Delay."

6. Once the first sample is complete, click "Solve" to view the results.

7. Then click "Save" to save the observation data to a spreadsheet.

8. For subsequent sample observations, repeat step two.

Figure 5 shows the process of measuring worker effectiveness using the FMR-Solver.

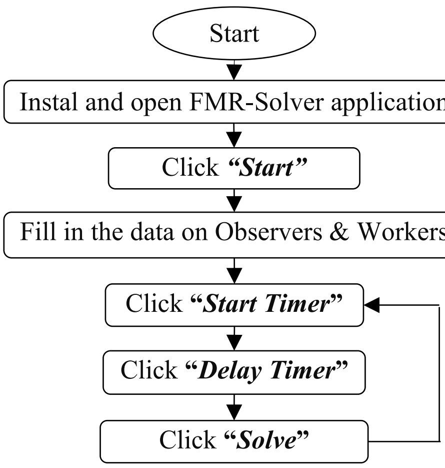

Figure 5. FMR-Solver Application Workflow

Efficiency Measurement Techniques

The efficiency assessment techniques are carried out as follows.

1. Record the activities of workers installing sloof reinforcement using video recordings.

2. Perform effectiveness measurement procedures using the conventional Five-Minute Rating method or using the FMR-Solver application tool.

3. Record and compare the duration of the effectiveness calculation for both methods.

4. Draw conclusions regarding the efficiency value of using the FMR-Solver application tool.

Application Assessment based on the Respondents' Perceptions

The FMR-Solver application was assessed based on several aspects to evaluate its usability and user comfort. Table 2 shows the assessment aspects and their explanations.

Table 2. Assessment Aspects

No.	Application Assessment Indicators	References
1	**Stability**	
	- The application does not crash or suddenly stop when in use. - No errors occur during use. - The application remains responsive even when used for a long time. - The application does not require repeated restarts to function properly.	Bevan et al. (2016) Pressman (2005) Hoehle & Venkatesh (2015) Moumane et al. (2016)
2	**Accurateness**	
	- The application produces the same output as the conventional method.	Stoyanov et al. (2016)
3	**Understandability**	
	- The application is easy to understand and use with a PDF user manual and technical instructions in the application. - The icons and symbols used in the application are clear and consistent with their functions. - The application provides clear guides/tutorials.	Hoehle & Venkatesh (2015) Weichbroth (2020) Albert & Tullis (2013)
4	**Operability**	
	- The application has practical operating steps. - The buttons and controls in the application work well.	Kurniawan (2004) Lewis (2018)
5	**Usefulness**	
	- This application helps users become more efficient. - This application is useful for assessing worker effectiveness.	Amin et al. (2014) Brooke (1996)
6	**Attractiveness**	
	- The application design is simple and straightforward. - The font and text size in the application are easy to read. - The calculation results are clearly displayed. - The visual elements in the application are not excessive, making it comfortable to view.	Hoehle & Venkatesh (2015) Silvennoinen et al. (2014) Ngadiman et al. (2015) Rubin & Chisnell (2008)

In terms of respondent assessment, the researcher established the following steps:

1. Providing the application and work videos to calculate effectiveness through the application that had been developed.

2. Providing a questionnaire form and requesting assessments from respondents regarding the application.

3. Analyzing the assessments from the data obtained from the respondents. The analysis was carried out using the Likert scale method obtained from the questionnaire with the help of Google Forms and Microsoft Excel.

Respondent Limitations and Case Study Determination

This study requires respondents to assess the practicality of the application. Respondents are limited by the following criteria:

1. Is a practitioner in the construction sector

2. Has conducted measurements of worker effectiveness or productivity using scientific methods (Januardi et al., 2024) such as work sampling, Five-Minute Rating, filed rating, dan time studies (e.g., crew balance chart, cycle chart, process chart and method productivity delay).

3. Are willing to measure worker effectiveness using FMR-Solver with a pre-determined case study before the application assessment.

4. The number of application evaluators is five. This is sufficient to assess usage, with findings nearly as numerous as when using a larger number of respondents (Nielsen, 2012, in Resdiyani et al., 2021).

This restriction was imposed considering that the tool used is intended for use in the construction sector, although it does not rule out the possibility of its use in other sectors for measuring performance effectiveness. In addition, it is difficult to find respondents who meet the criteria of having conducted scientific measurements of effectiveness or productivity. Therefore, the number of respondents in this study is only five.

The case study selected, which involved the reinforcement of a sloof, does not exclude the application of worker performance effectiveness measurement using this application in other types of work. This case study was randomly selected by the researcher from ongoing construction work at the building project at that time. Therefore, the application can be used for other types of work at all operational levels.

Questionnaire Analysis

In this study, the Relative Importance Index (RII) method was used to analyze data obtained through a questionnaire with a Likert scale of 1 to 5. RII serves to measure the relative importance of each item based on the respondents' answers. The RII calculation was performed using the following formula:

$$RII = \frac{\sum W}{A \ x \ N}$$

Where W is the sum of the weights of the respondents' responses, A is the maximum value of the Likert scale, and N is the number of respondents who answered the questionnaire (Qomusuddin & Romlah, 2022). This method is widely applied in quantitative research to identify respondents' priorities or satisfaction with various factors.

The RII approach allows researchers to rank items based on their level of importance according to respondents' perceptions (Boakye et al., 2023). RII results range from 0 to 1, with values closer to 1 indicating a higher level of importance. This method is widely used in various fields, especially for evaluating factors in project management, service quality, and customer satisfaction (Qomusuddin & Romlah, 2022). The values obtained from the RII method are then converted using a conversion scale table to determine the resulting categories.

Table 3 below is the conversion scale table.

Table 3. Conversion Scale

Achievement Level (%)	Categories
81-100	Highly Valid
61-80	Valid
41-60	Sufficiently Valid
21-40	Less Valid
0-20	Not Valid

Source: Qomusuddin & Romlah (2022)

RESULTS

Data Collection Stage

The data were collected from the Toko Laris construction project located at Jl. Jend. Sudirman No. 115, Purbalingga Lor Village, Purbalingga District. Data collection was conducted on September 2, 2024, to record the activities of two workers installing the sloof reinforcement. The work was recorded at 9:00 a.m. and 1:00 p.m., with each video lasting 37 minutes and 38 minutes, respectively. The location for data collection is shown in Figure 6, and photo of the sloof work process is shown in Figure 7.

Figure 6. Data Collection Location

Figure 7. Sloof Reinforcement Installation Work

Data Processing Stage

Data processing was carried out after all the necessary data had been collected. The necessary data included the delay time data of every single worker at each observation interval. Data processing in this study was carried out using two different methods, namely the conventional method and the FMR-Solver application tool method. The purpose of the data processing is to compare the results and the length of the process (from preparation to completion of calculations) of each method.

The main distinction between these two methods lies in the data collection process. The conventional method involves a multi-step manual process, which requires the preparation of two forms prior to observation. Form 1 is used to log delay durations, while Form 2 is used to calculate worker effectiveness based on the data in Form 1. After the preparations are ready, observation and calculation can be carried out.

In contrast, the FMR-Solver application streamlines the entire process. Users only need to install the application on an Android device, after which they can directly observe and record worker activity using the application interface. The app automatically processes the input and provides real-time calculations of worker effectiveness (Rochman, 2024).

Conventional Method

Data processing using the conventional method is carried out by observing recorded videos, recording the duration of workers' delays in 1 sample, recording up to the last sample on form 1, then calculating the Five-Minute Rating effectiveness on form 2.

The following tables are forms 1 and 2. On form 1, the observer writes down the start and end times of the delay for each sample and notes the seconds, minutes, and hours.

Table 4. Form 1 for Observation

Form-1: Five-Minute Rating Form		
Observer's Name : Saeful Rochman		
Job Title : Reinforcement Work on the Sloof		
No	**Worker 1**	**Worker 2**
1	-	-
2	06:32 - 06:57	-
3	12:33 - 13.02	-
4	-	-
5	-	23:41 - 24:21
6	-	-
7	-	-
8	-	-
9	44:15 - 45:00	42:11 - 42:58
10	-	-
11	-	-
12	-	-
13	-	-
14	01:07:21 - 01:08:05	-

In Form 2 below, the calculated Five-Minute Rating result is 100%, derived from the comparison between the number of Observed Effective instances and the Total Observed samples, which is 28 out of 28 (28/28). This outcome indicates that in each of the 28 observation intervals, the worker was considered effective. The 100% rating is justified by the fact that the duration of delays in each sample remained below 50% of the five-minute observation window.

Table 5. Form 2 for Effectiveness Analysis

Form-2: Five-Minute Rating Form				
Observer's Name : Saeful Rochman				
Job Title : Reinforcement Work on the Sloof				
No	**Worker 1**	**Worker 2**	**Observed Effective**	**Five-Minute Ratings %**
1	✓	✓	2	100%
2	✓	✓	2	100%
3	✓	✓	2	100%
4	✓	✓	2	100%
5	✓	✓	2	100%
6	✓	✓	2	100%
7	✓	✓	2	100%
8	✓	✓	2	100%
9	✓	✓	2	100%
10	✓	✓	2	100%
11	✓	✓	2	100%
12	✓	✓	2	100%
13	✓	✓	2	100%
14	✓	✓	2	100%
Total Observed			28	
Observed Effective			28	
Effectiveness			100%	

Application Tool Method

Data processing using the FMR-Solver application tool was conducted by observing the recorded video of construction activities. During the observation, delay occurrences were directly input into the FMR-Solver application, which enables automatic calculation of worker effectiveness (Rochman, 2024). Unlike the conventional method, which requires manual entry and post-observation calculations, this digital tool streamlines the process by integrating real-time data entry and instant processing within the application interface. Table 6 presents the observation results obtained using the FMR-Solver. It records the calculated Five-Minute Rating effectiveness and the duration of delays for each observation sample.

Table 6. FMR-Solver Spreadsheet

Observer's Name : Saeful Rochman				
Job Title : Reinforcement Work on the Sloof				
No	**Worker 1**	**Worker 2**	**Observed Effective**	**Five-Minute Rating %**
1	✓	✓	2	100%
2	✓	✓	2	100%
3	✓	✓	2	100%
4	✓	✓	2	100%
5	✓	✓	2	100%
6	✓	✓	2	100%
7	✓	✓	2	100%
8	✓	✓	2	100%
9	✓	✓	2	100%
10	✓	✓	2	100%
11	✓	✓	2	100%
12	✓	✓	2	100%
13	✓	✓	2	100%
14	✓	✓	2	100%
Total Observed			28	
Observed Effective			28	
Effectiveness			100%	

Comparison of the Results

There is no difference between the results calculated using the conventional method and the application tool method, which means that the application can be considered to provide accurate results.

Table 7. Comparison of Worker Effectiveness between Conventional Methods and FMR-Solver

Methods	Ratio Observed	Five-Minute Rating
Conventional	28/28	100%
FMR-Solver	28/28	100%

Efficiency of Application Tools

The efficiency of the application is assessed by comparing the conventional process of observation to obtain the Five-Minute Rating results with the application tool method. The data required for this calculation includes the duration of creating the draft table on the form, the duration of observation, and the duration of calculating the Five-Minute Rating results. The objective is to determine the efficiency value when using application tools compared to conventional methods. Table 8 provides information on the duration.

Table 8. Duration of Conventional Methods

No	Activities	Duration (second)
1	Preparation of draft tables for forms 1 and 2	449
2	Observation of workers (14 samples)	4,391
3	Data calculation	755
	Total	5,595

Based on conventional observation methods, there are three steps to obtain labor effectiveness. The time required to obtain the data using conventional observation methods to 14 samples is 5 minutes per sample, resulting in 5,595 seconds or 1 hour 33 minutes 15 seconds.

Table 9. Measurement Duration with Tools

No	Activities	Duration (second)
1	Observation of workers (14 samples)	4,328
	Total	4,328

Based on observations using the FMR-Solver application tool, there is one step to obtain labor effectiveness. The time required to obtain labor effectiveness using the conventional observation method of 14 samples is 5 minutes per sample, resulting in 4,328 seconds or 1 hour 12 minutes 8 seconds.

Table 10. Efficiency in Using Tools

No	Methods	Duration (second)
1	Conventional	5,595
2	FMR-Solver Application	4,328
	Difference	1,267
	Efficiency of application tools	22.6%

Based on the results of comparing the duration of observations of labor effectiveness measurements using conventional methods with the FMR-Solver application tool method, the FMR-Solver application tool method is 22.6% more efficient than conventional methods. Thus, FMR-Solver can make observations more efficient.

Application Assessment (User Perception)

The respondents in this study were practitioners who had used the Five-Minute Rating method and researched the performance/productivity of construction operations. The following is the profile of the respondents:

1. Respondent 1
   Agency/Company : PT Sarana Anugerah Perdana
   Qualification : Contractor
   Position : Site Manager
   Education : Bachelor's Degree in Civil Engineering

2. Respondent 2
   Agency/Company : KemenPUPR
   Qualification : Government
   Position : Technical Field Facilitator
   Education : Bachelor's Degree in Civil Engineering

3. Respondent 3
   Agency/Company : CV GCC
   Qualification : Design Consultant
   Position : Deputy Director
   Education : Bachelor's Degree in Civil Engineering

4. Respondent 4
   Agency/Company : KemenPUPR
   Qualification : Government
   Position : Technical Field Facilitator BSPS
   Education : Bachelor's Degree in Civil Engineering

5. Respondent 5
   Agency/Company : PT. Bangkit Manunggal Karya Teknik
   Qualification : Contractor
   Position : Quantity Surveyor
   Education : Bachelor's Degree in Civil Engineering

Respondents provided their perceptions of the application developed by the researchers by evaluating their experience using the FMR-Solver application through a Google Form questionnaire.

Based on the analysis of the respondents' questionnaires using the Likert scale and RII, the lowest RII value was 76.0%, and the highest was 96.0%, which means it is valid and highly valid according to Table 3 of the conversion scale. The rankings were sorted from highest to lowest percentage, but there were some ties. These were then sorted by highest score, but some remained tied even after sorting by highest score. These tied values are found in ranks 1, 2, and 3.

The results show that the application is suitable from several aspects of the indicators mentioned in Table 11. Based on the highest assessment, FMR-Solver was approved by respondents with maximum scores for producing the same effectiveness values as conventional methods, being easy to use, and providing measurement duration efficiency.

Table 11. Respondent Assessment Analysis

No	Application Assessment Indicators	Amount (W)					N	RII	Rank
	Score	1	2	3	4	5			
1	**Stability**								
	- The application does not crash or suddenly stop when in use.	-	-	1	1	3	5	88%	3
	- No errors occur during use.	-	1	1	-	3	5	80%	8
	- The application remains responsive even when used for a long time.	-	1	1	1	2	5	76%	9
	- The application does not require repeated restarts to function properly.	-	-	2	-	3	5	84%	6
2	**Accurateness**								
	- The application produces the same output as the conventional method.	-	-	-	1	4	5	96%	1
3	**Understandability**								
	- The application is easy to understand and use with a PDF user manual and technical instructions in the application.	-	-	-	1	4	5	96%	1
	- The icons and symbols used in the application are clear and consistent with their functions.	-	-	-	2	3	5	92%	2
	- The application provides clear guides/tutorials.	-	-	-	2	3	5	92%	2
4	**Operability**								
	- This application has practical operating steps.	-	-	1	1	3	5	88%	3
	- The buttons and controls in the application work well.	-	1	-	1	3	5	84%	5
5	**Usefulness**								
	- This application helps users become more efficient.	-	-	-	1	4	5	96%	1
	- This application is useful for assessing worker effectiveness.	-	-	-	3	2	5	88%	4
6	**Attractiveness**								
	- The application design is simple and straightforward.	-	1	-	1	3	5	84%	5
	- The font and text size in the application are easy to read.	-	1	-	3	1	5	76%	10
	- The calculation results are clearly displayed.	-	-	-	2	3	5	92%	2
	- The visual elements in the application are not excessive, making it comfortable to view.	1	-	-	1	3	5	80%	7

DISCUSSION

The FMR-Solver application offers a practical solution to measure worker performance effectiveness, particularly by improving time efficiency in the measurement process. This aligns with the digitalization trends in the construction sector and related fields (Sulartopo et al., 2023; Hermawan & Sudirman, 2023). The application is especially useful for contractors seeking to monitor worker performance effectiveness, either periodically to maintain performance rhyth or during instances where signs of performance decline are observed. If it is proven, it can be continued with productivity measurements such as the MPDM method, Crew Balance Chart, Process Chart, or Cycle Chart. This is to identify issues and recommend improvements based on the findings (Januardi et al., 2024).

According to Yates (2014), a worker is considered effective if delays account for less than 50%. Furthermore, an effectiveness rating between 80–90% indicates high efficiency, while ratings in the 50–60% range reflect lower efficiency. It is important to note that this method only provides a classification of worker status—productive or inactive—during the observation period.

The concept of effectiveness assessment in the Five-Minute Rating differs from the assessment in work sampling, which evaluates three conditions based on worker activities: effective work, essential work, and ineffective work (Yates, 2014) or productive, semi-productive (involved in supporting the main activity), and non-productive (Dozzi & AbouRizk, 1993). This is because the output values they produce are also different. The Five-Minute Rating focuses on the worker's effectiveness ratio, so what is compared is the duration of work without delays with the duration of observation time. Work sampling, on the other hand, focuses on the labor utilization rate by conducting brief observations (events) without a specific duration like the Five-Minute Rating, and classifying those events into the three conditions mentioned above. Additionally, the Five-Minute Rating conducts continuous observation like the time study concept, albeit with a short observation duration (1 or 5 minutes), while work sampling uses a probability concept. Thus, the required sample size can reach 384 observations to achieve a 95% confidence level (Dozzi & AbouRizk, 1993).

Developing the FMR-Solver application using the MIT App Inventor has been reported not difficult (Rochman, 2024). Individuals without prior experience in software development or coding can complete this application in four months. The most important prerequisite for the development lies in the individual's understanding of the technical procedures of the measurement method to be developed.

Despite its practicality, the FMR-Solver application has several limitations

1. The application can only be used to measure the effectiveness of the Five-Minute Rating method.

2. The application is not yet available for public through the Play Store. However, those who need it for research and field use are welcome to contact the author.

3. Raw data will be automatically generated in the spreadsheet of the author's first email account as the application developer. The results of the effectiveness calculation can be directly obtained in the application.

4. The explanation of the application's usage is still in Indonesian language.

This study opens up opportunities for further research in the form of:

1. The FMR-Solver has the potential to be a model for the development of Adv-FMR, which is currently being developed by Kim et al. (2022), where IoT or ICT support is used to measure effectiveness and produce outputs with minimal error.

2. The FMR-Solver can be further developed by organizing the recorded time and duration database to make it open access for others by adding a user registration function (Hamzan et al., 2022). This includes adding a voice note function if something important is observed during observation that needs to be recorded without having to write it down (Aziz et al., 2024).

3. Further testing of the FMR-Solver application is recommended across construction tasks at the operational level to validate the application's availability for all types of work.

CONCLUSION

The use of the FMR-Solver application enhances the efficiency of the FMR method by 22.6% compared to the conventional approach. This improvement in efficiency is attributed to the application's ability to integrate observation, calculation, and result presentation within a single digital interface. In contrast, the conventional method requires a multi-step process involving the preparation of manual forms (Form 1 and Form 2), manual data recording, and subsequent calculations to obtain the result. In the Five-Minute Rating measurement using the conventional method and the FMR-Solver application tool for reinforcing bar installation work, the same effectiveness results were obtained, namely 100%. Both the conventional and digital methods yielded identical effectiveness outcomes in the case study of reinforcing bar installation work, with each reporting a Five-Minute Rating of 100%, which indicated consistent measurement results of both approaches.

User perceptions of the FMR-Solver application were evaluated based on six key indicators—stability, accuracy, understandability, operability, usefulness, and attractiveness—resulting scores between 76.0% and 96.0%. These values are categorized as valid to highly valid. Such findings support the FMR-Solver as a reliable and efficient tool for measuring worker effectiveness.

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