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Optimizing work movements to reduce injury risk: Application development with Methods-Time Measurement and WebQual analysis

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ABSTRACT
Optimizing work movements is crucial for enhancing efficiency and reducing injury risks in industrial environments. Methods like Methods-Time Measurement (MTM), Work Factor (WF), and Maynard Operation Sequence Technique (MOST) are commonly used to analyze and optimize the workstations. However, there remains a lack of accessible tools for rapid and accurate time measurement. This study aims to develop a web-based and Android application designed to assist both students and professionals in calculating work times and optimizing movements (such as: material handling) more efficiently. The application was evaluated using the WebQual method, focusing on usability quality, information quality, and interaction quality. Evaluation results yielded scores of 82.3% for usability, 85.7% for information quality, and 80.5% for interaction quality. Validity and reliability tests demonstrated a Cronbach's Alpha coefficient of 87%, indicating very high reliability. The integration of MTM within this application has proven effective in accelerating work time calculations compared to manual methods and in improving movement efficiency, which directly contributes to reducing injury risks.

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1. INTRODUCTION

In the modern industrial world, optimizing work movements is essential for both enhancing productivity and ensuring worker safety. Inefficient or non-ergonomic movements significantly contribute to workplace injuries, particularly Musculoskeletal Disorders (MSDs) [1]. According to the International Labour Organization (ILO), MSDs account for approximately 40% of the total compensation costs for work-related injuries and diseases, making them one of the most significant occupational health issues worldwide [2]. Poor ergonomic conditions, repetitive manual tasks, and insufficiently optimized workflows are key contributors to this issue, resulting in reduced worker productivity, increased absenteeism, and higher operational costs [3]. In many industrial assembly environments, tasks such as loading, unloading, pushing, pulling, and material handling remain manual, which exacerbates the risk of MSDs and other workplace injuries [4]. This highlights the need for companies to adopt systematic approaches to analyze and optimize work movements, not only to enhance operational efficiency but also to ensure safer, more sustainable working environments [5]. Furthermore, many tasks in industrial assembly environments still involve manual activities such as loading and unloading, pushing and pulling, and material handling. The high prevalence and economic burden of MSDs underscore the immediate need for innovative tools that can address inefficiencies in work movement analysis and improve ergonomic conditions in industrial settings. Therefore, companies must adopt a systematic approach to analyze and optimize work movements to prevent injuries and ensure safe, efficient operations [6].

Time management has become a critical resource in industrial operations, particularly in tasks that rely on standardized time measurements. The Predetermined Motion and Time System (PMTS) is a well-established framework for analyzing and measuring the time required to complete specific tasks based on the movements involved [7]. This system plays a crucial role in optimizing labor efficiency, establishing standard times for work processes, and reducing delays, which ultimately improves productivity [8]. Among the PMTS methodologies, Methods-Time Measurement (MTM) is notable for its precision. It breaks down tasks into measurable elements and assigns accurate standard times using Time Measurement Units (TMUs), which makes it particularly useful for detailed time and motion analysis [9].

Several methods frequently employed within PMTS include Work Factor (WF), Maynard Operation Sequence Technique (MOST), and Methods-Time Measurement (MTM) [10]. Each of these methods offers a unique approach to analyzing and optimizing work movements. For example, WF divides work into basic motion elements and is commonly used for time estimation such as reaching, carrying, and assembling [11]. Meanwhile, MOST focuses on analyzing sequences of movements, particularly in object transport [12]. MTM stands out due to its precision in measuring each basic movement using Time Measurement Units (TMU), resulting in highly accurate standard times for each movement [13–15]. Despite the effectiveness of PMTS methods, significant challenges persist in their practical application [10,15]. These challenges primarily stem from the limitations of manual processes for identifying movements and measuring time [16]. Such manual approaches are often inefficient, subjective, and prone to errors, resulting in inaccurate assessments and contributing to non-ergonomic movements that ultimately affect worker safety and productivity [5,17]. Furthermore, manual processes make movement identification subjective and lead to inconsistent time measurements [16].

MTM, based on time studies within PMTS, enables the decomposition of assembly processes into small, measurable steps, with each basic worker movement individually timed [18,19]. MTM covers nine basic movements of the fingers, hands, and feet [15,20]. There are approximately 400 standard times for performing these basic movements, each represented by symbols derived from basic English vocabulary. Depending on performance variables (such as movement length, type, and accuracy level), corresponding normal times (t_n) are presented in tables for reference [21,22]. Additionally, MTM can be utilized to design and optimize workplaces [23]. MTM, particularly when integrated with computer vision and deep learning technologies, has shown promise in automating the identification and measurement of work movements [24]. This integration allows for the development of motion-capture systems capable of automatically classifying movements, eliminating repetitive motions, streamlining workflows, and optimizing ergonomic conditions [25,26]. By automating time and motion analysis, such systems help improve workplace safety and operational efficiency, as well as reduce injury risks [27]. These advancements demonstrate the importance of designing efficient work systems from the outset. Without systematic intervention, the continued reliance on manual processes will exacerbate workplace injuries, inflate operational costs, and limit industrial productivity.

The objective of this research is to develop an application that employs MTM to automatically track and analyze work movements. By automating the identification and measurement of work time, this tool aims to increase both efficiency and accuracy while significantly reducing workplace injury risks. To ensure the developed application meets high-quality usability standards, usability testing will be conducted using the WebQual method [28]. This method is widely used to evaluate the quality of web-based applications, particularly in terms of information quality, system quality, and service interaction quality. These dimensions align closely with key aspects of user experience (UX), such as ease of use, information clarity, and user satisfaction. Therefore, WebQual is a relevant and appropriate tool for assessing the usability of the MTM application, as it provides structured insights into potential weaknesses in the user interface [29, 30]. Moreover, WebQual supports the evaluation of user efficiency and comfort, which are critical for improving overall user experience. By identifying specific areas for improvement, this method contributes to enhancing the usability and effectiveness of the application [31, 32]. By developing an application capable of automatically identifying and analyzing movements using MTM, this research contributes directly to improving workplace safety and work efficiency. The application offers short-term benefits, such as enhanced safety, while also providing long-term advantages like cost savings and overall productivity growth.

2. METHODS

The process of designing the MTM application involves several key stages that serve as a guide throughout the development process. As illustrated in Figure 1, this research includes four essential phases: problem identification, data collection, application development, and analysis.

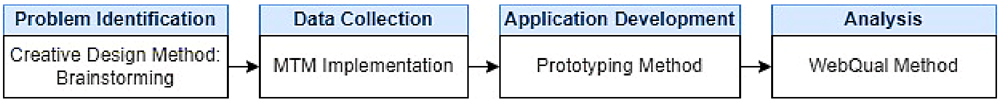


Figure 1. Research flow

2.1. Problem Identification

This research employs a creative design method aimed at stimulating creative thinking and generating ideas. The method is focused on overcoming mental barriers to creativity and broadening the scope of solution exploration. In this approach, brainstorming serves as the primary technique for identifying problems and developing innovative ideas to address them [33]. Initially, the meeting leader explains the problem to the participants and provides guidance on how to effectively engage in the brainstorming session. To ensure a clear understanding of the issue, the leader prepares relevant facts and gives an introductory briefing. The next step involves reformulating the problem to further clarify it, paving the way for relevant solutions without the need for additional brainstorming.

2.2. Data Collection

After identifying the problem, the next phase is applying the MTM method by collecting relevant work movement data. This step involves selecting the movement elements to be analyzed and determining the measurement methods used. Technical procedures are followed to ensure the collected data is both relevant and accurate.

2.2.1 Identifying and Selecting Movement Elements

The first step in identifying and selecting movement elements is thoroughly analyzing the work process under review. This comprehensive analysis is essential for understanding each step and activity involved, as illustrated in

Figure 2. The process begins with observing the work activity and identifying it as basic movement elements. These movements are then matched with the MTM motion reference tables, which serve as the standard for determining work movement results. The movement elements include activities such as reaching, grabbing, carrying, and placing objects. Ultimately, this process results in the identification of movements, which can then be further evaluated for efficiency and ergonomics.

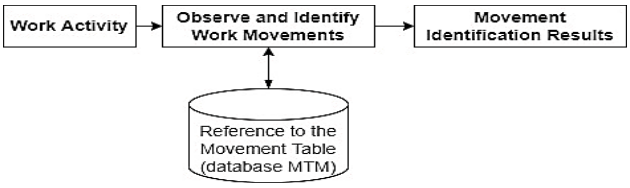


Figure 2. Identify movement elements

2.2.2 Initial Data Collection

In the following stage, initial data collection begins with direct observation of students and faculty as they perform identified tasks in the laboratory. The aim of this observation is to understand the duration and frequency of each movement element. After observing, time measurements are taken using tools such as a stopwatch to record the duration of each observed movement. The data gathered from these measurements is then used to establish standard times for each movement, serving as the basis for further analysis. This data will be used as input in the development of the MTM application.

2.3. Application Development

The application development phase involves integrating the data from MTM tables into an application format, including the algorithms and models used to measure and analyze work movements. Initially, MTM is applied within the application by designing an algorithm that processes movement data and calculates time based on MTM standards. Technical details regarding coding are then outlined to explain how the MTM method is implemented in the application's code. This process involves developing features that support MTM analysis, such as interfaces for data input and tools for visualizing analysis results.

This research adopts the prototyping development method, which was selected for its ability to facilitate intensive interaction between developers and users throughout the development process [34]. With this approach, developers and users can actively communicate to identify general needs without detailing the data input, processing, and output requirements. The prototyping method was chosen due to its suitability for the research conditions, proving effective in aligning the application with end-user expectations.

2.3.1 Functional Requirements Analysis

The first step in system development is the analysis of functional requirements. This phase serves to listen to and understand the needs of the users. During this analysis, the system requirements are defined and described in detail, including the scope of the system to be developed. The result of this analysis is a system design that will serve as the guide for subsequent development.

In this research, the application is designed to simplify the calculation of standard times. The application needs to function on both web-based and Android platforms. The request and response data process in this application involves using an Application Programming Interface (API), which queries the database. Figure 3 shows the architecture flow of the developed MTM application.

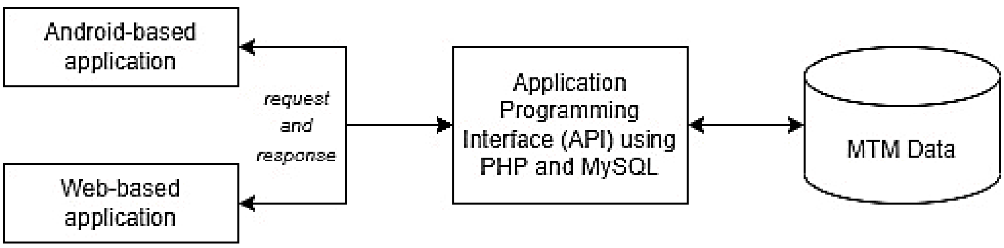


Figure 3. MTM application process flow

2.3.2 System Design

The next stage is system design, which aims to translate system requirements into a software representation. In this research, the design involves two main actors, namely users and admins, as illustrated in Figure 4. Users in this system include students and faculty who will be testing the application, while the administrator role is held by the head of the work system design and ergonomics laboratory. The use case diagram for the MTM system displayed in Figure 4 supports various key MTM functions, particularly related to work time measurement simulation and data management. A login feature is added to ensure data security between the different roles accessing the system. Once logged in, both actors can access the "See Movement" feature, allowing them to view movement or activity data relevant to their needs. The core feature of this system is the "Running Simulation" accessible by both actors, which is designed to simulate specific movement scenarios a key element in system operation.

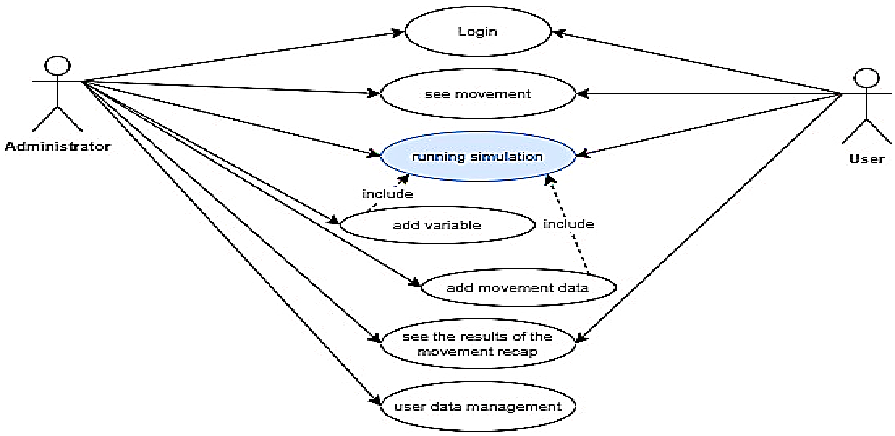


Figure 4. Use case diagram for MTM applications

To support this simulation, administrators have additional capabilities to add variables and movement data via the "Add Variable" and "Add Movement Data" features. These features are designed to provide greater flexibility and accuracy in the simulation, allowing the administrator to adjust parameters and data as needed for the simulation. After the simulation is completed, the system offers the "See the Results of the Movement Recap" feature, where both the administrator and users can view the recap of movements simulated. This feature provides crucial insights for users to analyze and understand the simulation results. Additionally, the administrator has access to the "User Data Management" feature, enabling the management of user data within the system. This feature is vital in ensuring the security and integrity of user data, as well as allowing the adjustment of access and privileges based on user roles.

2.4. WebQual Analysis

The primary objective of this research is to develop an MTM-based computer system, designed as a digital application to track and analyze work movements. This system utilizes advanced computational processes to automate the identification and measurement of work time, with the aim of improving time efficiency and reducing workplace injury risks. To ensure the developed system meets high usability standards, the interface was analyzed and evaluated using the WebQual method [35]. The WebQual approach was chosen for its ability to comprehensively assess usability across three critical dimensions: information quality, system quality, and service interaction—all of which are fundamental components of User Experience (UX) for digital systems. This method is particularly suitable for evaluating web-based and mobile applications like the MTM tool, as it focuses on user-centric aspects such as information clarity, ease of use, and user satisfaction. Additionally, WebQual helps identify potential weaknesses in the user interface, enabling targeted improvements to enhance the overall effectiveness of the application.

Each WebQual dimension addresses specific aspects of usability to ensure a comprehensive evaluation. The ease-of-use dimension assesses the intuitive design and simplicity of navigation, enabling users to operate the application without difficulty [36]. The information quality dimension focuses on the accuracy and relevance of the data provided, which are critical for effective decision-making in work time management. Meanwhile, the service interaction dimension evaluates aspects such as trust, data security, and technical support, emphasizing user empathy and system reliability. These dimensions are evaluated through a series of structured questions, as outlined in Table 1, ensuring that the system's usability and user experience are thoroughly examined and optimized.

3. RESULTS

3.1. MTM Application Results

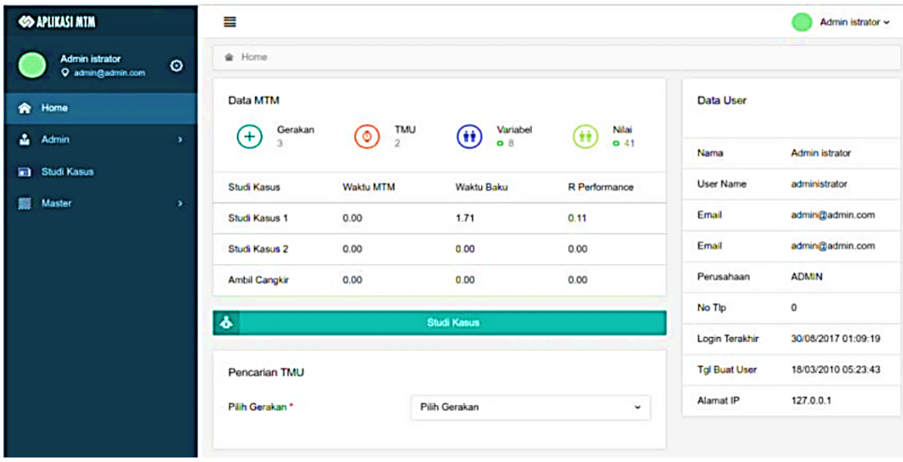
This research successfully developed a web-based and Android-based MTM application to assist students and users in learning optimal work movements and measuring work time more efficiently and accurately. The application, as shown in Figure 5, consists of two versions: the web-based application (Figure 5.a) and the Android application (Figure 5.b). It was developed using a prototyping approach, which enabled iterative design improvements based on user feedback during the development process.

Table 1. WebQual dimensions

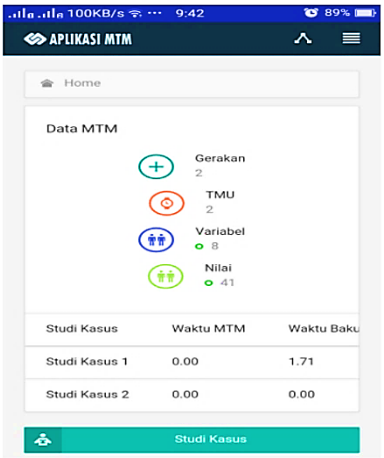
Dimension	Aspects Evaluated	Question
Usability Quality	1. Ease of navigation on the website.	- How easy is it for you to find the information you are looking for in this application?
	2. Intuitive and user-friendly interface.	- Is the interface of this application intuitive and easy to use?
	3. Ease of finding desired information.	- How quickly can you find the information you need in this application?
	4. The organization of information and content layout.	- How do you rate the organization of information and content layout in this application?
	5. Visual appeal and professional appearance.	- How do you find the visual appeal and professional appearance of this application?
	6. Consistency of design across the website.	- How consistent is the design of this application across different pages?
	7. Speed of access and page load time.	- How fast is the application to access and how long does it take to load pages?
	8. Mobile-friendliness and responsiveness.	- How well does the application function on mobile devices, and how responsive is its interface?
Information Quality	1. Accuracy of the information provided.	- How accurate is the information provided by this application?
	2. Relevance and usefulness of the content.	- How relevant and useful is the content provided by this application?
	3. Clarity and understandability of the information.	- How clear and understandable is the information presented by this application?
	4. Completeness and depth of information.	- How complete and in-depth is the information available in this application?
	5. Timeliness and currency of the information.	- How current and timely is the information provided by this application?
	6. Consistency of information across different sections.	- How consistent is the information provided across different sections of the application?
	7. Credibility and trustworthiness of the content.	- How credible and trustworthy is the content provided by this application?
Interaction Quality	1. Responsiveness and promptness of customer service.	- How responsive and prompt is the customer service in addressing your questions or issues?
	2. Availability and accessibility of support options.	- How available and accessible are the support options in this application?
	3. Effectiveness of problem resolution and support.	- How effective is the support in resolving issues and problems?
	4. Personalization and customization options for users.	- How well does the application allow for personalization and customization for users?
	5. Trust in the system, including transaction security.	- How much trust do you have in the system, including the security of transactions?

Dimension	Aspects Evaluated	Question
	6. User feedback mechanisms and their effectiveness.	- How effective are the user feedback mechanisms in this application?
	7. Ease of completing transactions or other interactive tasks.	- How easy is it to complete transactions or other interactive tasks in this application?

After thorough testing, the application is now being used locally in the work system design and ergonomics laboratory at Universitas Bina Darma, where it serves as a practical tool for students. This application supports students in observing, analyzing, and optimizing work movements using the MTM method. All interface elements and features, including the ability to add, manage, and simulate work movements, were fully developed to align with the research objectives of optimizing work movements and enhancing time efficiency.



(a)

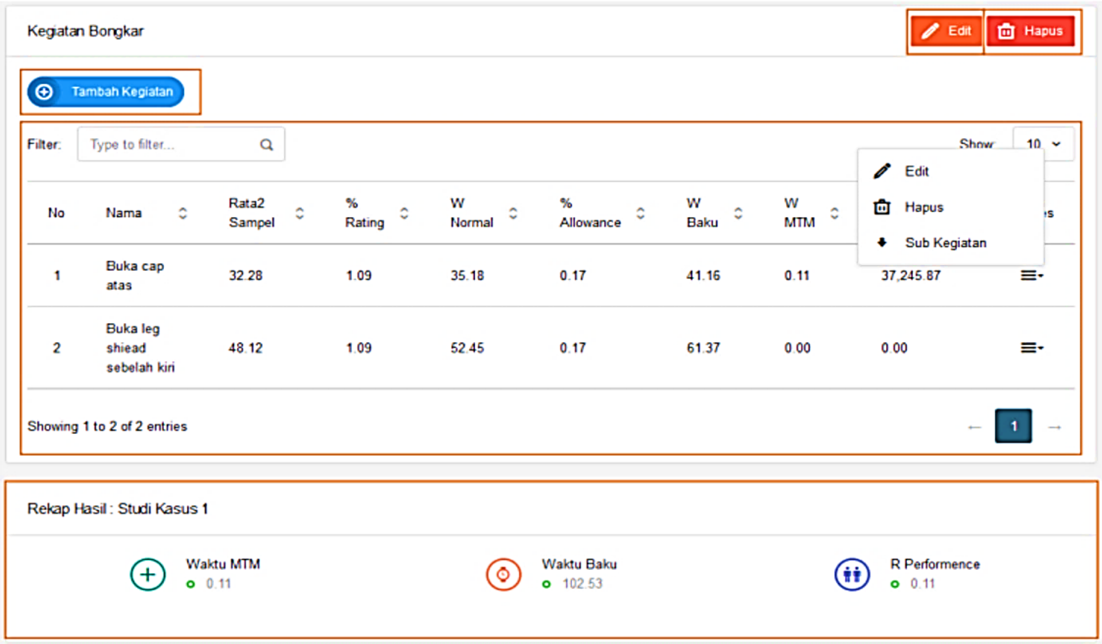


(b)

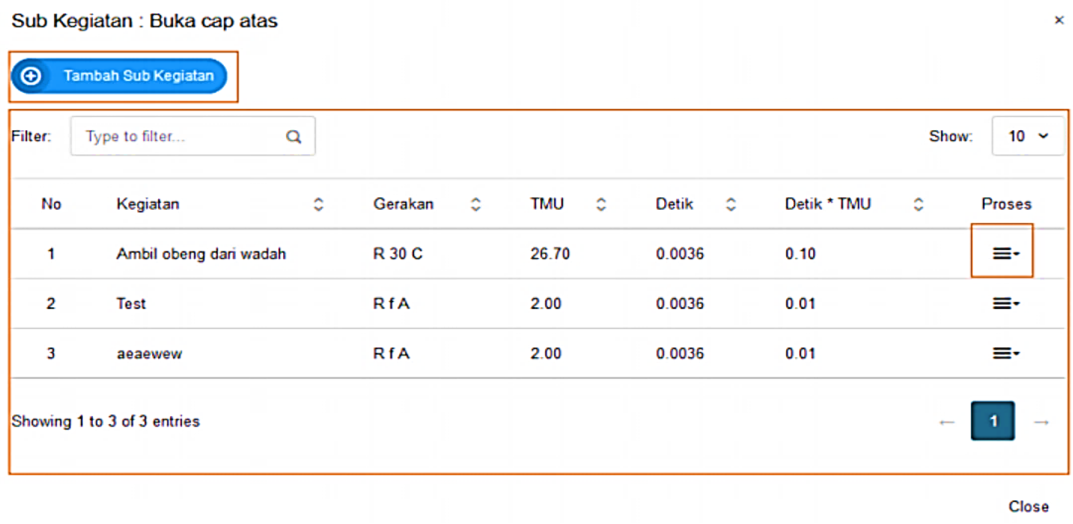
Figure 5. Results of MTM application development, (a) Web-based and (b) Android-based

Figure 6 presents the critical stages in the MTM calculation simulation based on a case study, organized into three main processes. The first stage, the Activity Addition Process (Figure 6.a), features an intuitive interface allowing users to add new activities to the system through the "Add Activity" function. Each added activity is displayed in a detailed table that includes metrics such as the average sample, rating percentage, normal time, allowance, standard time, and MTM time. Users can edit, delete, or add sub-activities via a context menu, facilitating efficient activity management. In the second stage, the Sub-Activity Addition Process (Figure 6.b), users describe sub-activities in detail under the defined main activities. Sub-activities are added using the "Add Sub-Activity" feature, and key information is displayed in a table format. This table includes technical parameters such as performed movements, TMU, conversion of TMU to seconds, and the product of seconds and TMU. This data presentation allows for a thorough analysis of each element affecting the total activity duration, enabling process optimization. Finally, the Activity Simulation Summary (Figure 6.c), provides a visual recap of the simulation results, including MTM time, standard time, and performance rating. This summary offers quantitative insights into the efficiency and effectiveness of the analyzed performance, supporting quick and accurate evaluations for managerial decision-making related to process optimization.

The analysis of trial results indicates that the application's interface is successfully built with intuitive navigation and responsive design across various devices. Overall, the MTM application has proven beneficial in supporting work time measurement and contributing positively to education and industry applications. However, further analysis and evaluation are needed to confirm the application's usability quality and ensure it meets user expectations.



(a)



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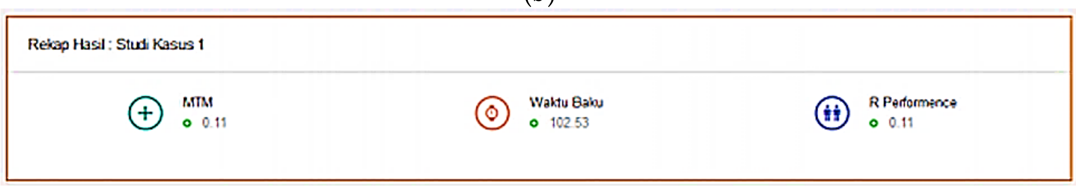

(c)

Figure 6. MTM calculation simulation based on a case study: (a) Activity addition process, (b) Sub-activity addition process, and (c) Summary of activity simulation results

3.2. Usability Testing Results

The usability quality of the MTM application was evaluated using the WebQual method. Questionnaires were distributed to 67 respondents who observed posture and work movements in the work system design and ergonomics laboratory. The sample size of 67 students was determined using the Slovin formula, with a total population of 80 students [37]. Using a 95% confidence level and a 5% margin of error, the minimum calculated sample size was 66.67. The questionnaire assessed quality indicators such as usability, information quality, and service interaction, as outlined in Table 2. A validity test confirmed that the questionnaire accurately measured the intended usability aspects. This validity was evaluated through factor analysis, which examined how well each questionnaire item represented the measured dimensions. The purpose of these tests was to ensure that the questions within the questionnaire were valid (i.e., they accurately assess the intended aspects of usability, such as information quality, system quality, and service interaction) and reliable (i.e., they consistently measure these aspects across different users and testing conditions).

The validity test results in Table 2 show that all indicators or variables in the questionnaire significantly correlate with the quality dimensions being measured: Usability Quality, Information Quality, and Interaction Quality. The Pearson correlation for each item across the three dimensions shows varying values, but all are statistically significant at both the 0.01 and 0.05 levels. This indicates that each question variable validly represents the intended dimension. Some question variables, such as X1.2, X1.4, and X1.5, show very strong correlations, with values above 0.850 for Usability Quality. All question variables for Information Quality (X2.1 to X2.7) also show significant correlations, ranging from 0.842 to 0.921, with X2.4 exhibiting the strongest correlation (0.921), indicating high representativeness for information quality. For Interaction Quality, all question variables (X3.1 to X3.7) show significant correlations, ranging from 0.781 to 0.897. Notably, X3.2 has the highest correlation (0.897), indicating strong suitability for measuring interaction quality.

Table 2. Validity test results

Pearson Correlation					
Usability Quality		*Information Quality*		*Interaction Quality*	
X1.1.	1.0	X2.1.	1.0	X3.1.	1.0
X1.2.	0.873	X2.2.	0.842	X3.2.	0.897
X1.3.	0.797	X2.3.	0.852	X3.3.	0.844
X1.4.	0.855	X2.4.	0.921	X3.4.	0.849
X1.5.	0.856	X2.5.	0.875	X3.5.	0.834
X1.6.	0.816	X2.6.	0.847	X3.6.	0.781
X1.7.	0.820	X2.7.	0.844	X3.7.	0.838
X1.8.	0.641				

To measure the consistency and reliability of the instrument, a reliability test was performed. The reliability test results, presented in Table 3, indicate that the research instrument exhibits very high internal consistency for the three main variables: Usability Quality (X1), Information Quality (X2), and Interaction Quality (X3). This is reflected by the very high Cronbach's Alpha values for each variable, with scores of 0.957 for Usability Quality, 0.968 for Information Quality, and 0.958 for Interaction Quality.

Table 3. Reliability test results

Variabel	Cronbach's Alfa	Conclusion
Usability Quality (X1)	0,957	Reliable
Information Quality (X2)	0,968	Reliable
Interaction Quality (X3)	0,958	Reliable

Cronbach's Alpha values above 0.7 are considered good, and the values obtained (above 0.9) demonstrate excellent reliability [38]. Thus, the values obtained in this study indicate that the instrument used has excellent internal consistency. This means that the items used to measure each variable tend to produce consistent results if retested under the same conditions. This high reliability reinforces the validity of the research findings, demonstrating that this instrument is capable of providing stable and reliable results when evaluating the intended qualities. Therefore, this instrument can be reliably used in further research or practical applications that require accurate and consistent measurements of the tested qualities.

To evaluate how each independent variable (Usability Quality, Information Quality, and Interaction Quality) influences the dependent variable, multiple regression analysis was conducted. Table 4 presents the results of the multiple regression analysis, assessing the influence of the three independent variables. The R-value (correlation coefficient) shows that Interaction Quality (X3) has the strongest relationship with the dependent variable, with an R-value of 81.3%, followed by Information Quality (X2) at 71.5%, and Usability Quality (X1) at 70%. These values indicate that all independent variables have a positive and reasonably strong correlation with the dependent variable. Furthermore, the R Square value indicates the proportion of variance in the dependent variable that can be explained by each independent variable. Interaction Quality (X3) has the highest R Square value, meaning that 66.2% of the variability in the dependent variable can be explained by this variable. Meanwhile, Information Quality (X2) explains 51.2%, and Usability Quality (X1) explains 49% of the variance. This shows that Interaction Quality (X3) is the strongest predictor compared to the other two variables.

The Adjusted R Square provides a more accurate picture by considering the number of independent variables in the model. The Adjusted R Square for Interaction Quality (X3) is 65.7%, for Information Quality (X2) is 50.4%, and for Usability Quality (X1) is 48.3%. Although there is a slight decrease from the R Square values, the adjustment confirms that Interaction Quality has the most significant impact. The Standard Error of the Estimate shows the standard error or standard deviation of the residuals, which measures the accuracy of the regression model in predicting the dependent variable. Interaction Quality (X3) has the lowest value (67.6%), indicating more accurate predictions compared to the other two variables. Finally, the Durbin-Watson values range from 1.906 to 1.942 for all variables, which are within the normal range (around 2), indicating no serious issues with autocorrelation of the residuals in this regression model.

Table 4. Multiple regression analysis results for each variable on the dependent variable

Variabel	R	R Square	Adjust R Square	Std. Error of the Estimate	Durbin-Watson
Usability Quality (X1)	0.700	0.490	0.483	0.830	1.906
Information Quality (X2)	0.715	0.512	0.504	0.813	1.942
Interaction Quality (X3)	0.813	0.662	0.657	0.676	1.927

4. DISCUSSION

The evaluation results indicate that the web-based and Android MTM application developed for work time measurement functions efficiently and has been well-received by users. Users reported that the application not only accelerates the process of calculating standard times but also reduces common errors in table reading, a frequent challenge in traditional MTM applications. This success demonstrates that digital and technology-based approaches can effectively overcome the limitations of manual methods traditionally used in the industry. As a result, the application shows significant potential for use beyond academic settings, particularly in industries that require accurate work time measurement, such as manufacturing and assembly.

Despite its good performance, the application may require further adjustments to be more adaptable to different industries. Variations in work processes and operational environments across industries could impact the application's effectiveness. Therefore, additional research focusing on real-world trials is needed to ensure that the application performs well in diverse industrial contexts, guaranteeing its generalizability and adaptability. Regression analysis findings revealed that Interaction Quality has the most substantial impact on user satisfaction compared to Usability and Information Quality [39]. This highlights the critical role of interface design and user interaction in determining the application's overall effectiveness. Based on these findings, it is recommended that developers focus on enhancing the interaction quality of the application, ensuring it remains intuitive and user-friendly, even in more complex working environments.

Additionally, performance optimization should be prioritized to reduce load times and improve the responsiveness of the application, particularly when handling large datasets or complex simulations.

For future development, the application should focus on improving the user interface (UI) to make it even more intuitive and user-friendly, with clearer instructions and simplified navigation. Performance optimization is also crucial to ensure that the application can handle large datasets and complex simulations smoothly, without delays. Expanding usability testing to include a broader group of users, particularly those with varying levels of experience, would provide valuable insights into how the application performs across different user profiles. Finally, ensuring better compatibility and responsiveness for the mobile version of the application will help cater to a wider range of devices and operating systems. These recommendations can serve as a foundation for other researchers or developers working on similar applications, helping to refine and optimize the product further.

5. CONCLUSION

This research successfully developed a web-based and Android application for optimizing work movements to reduce injury risks using MTM and WebQual quality analysis. The application is designed to provide an efficient solution for accurately measuring work time and assisting users, both students and practitioners, in identifying and optimizing movements that could potentially cause injuries. Testing results demonstrate that the application significantly accelerates the process of calculating work times, reduces errors associated with manual methods, and enhances operational efficiency. Validity and reliability tests show that the measurement instruments used in this research exhibit very high reliability, with Cronbach's Alpha values exceeding 0.9 for all variables. This indicates that the application is not only user-friendly but also provides accurate information and responsive interaction, which are crucial for its use in various operational conditions. Overall, the developed application proves effective in supporting work movement optimization and reducing injury risks. However, further research is needed to test the application's implementation across various industrial sectors to ensure its adaptability and broad applicability. Thus, the application holds significant potential to become a valuable tool in enhancing safety and work efficiency across different operational environments.

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