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DEVELOPMENT OF EXCEL-BASED BUILDING DEFECT MANAGEMENT SYSTEM USING BUSINESS PROCESS REENGINEERING IN EDUCATION BUILDING

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ABSTRACT

Effective maintenance of a university campus building is crucial to ensure the safety and well-being of its academic community. However, maintaining the building and its various equipment and assets can take time and effort. This study aims to optimize building maintenance by implementing Business Process Reengineering (BPR) and using an Excel-based application system to detect points of damage. The study analyzes the maintenance process's cost, duration, and damage reports using dashboard features such as Gantt chart diagrams. By comparing the Excel-based application system with the conventional system, we found that the former is more effective and efficient. The results show that the application system saves 12 hours of recapitulation time per week, increases labor productivity by 32.2%, and speeds up damage reparation by 5%.

1. INTRODUCTION

The construction of a structure is not a one-time event but a process consisting of numerous phases, including planning and implementation, utilization, preservation, and even demolition (Benachio et al., 2020). While the focus is often on the construction phase, the preservation and maintenance of the building are equally essential to ensure its longevity and continued use. Building maintenance combines technical and administrative measures to maintain and restore the building's function as initially designed (Frangopol & Liu, 2019). According to the Regulation of the Minister of Public Works 24 (2008), Article 1 is written, "Building construction is a development activity that includes the technical planning process and construction implementation, as well as building utilization, preservation, and demolition activities." The article explains that the preservation of buildings is also an essential component in building management. However, the construction of good buildings is sometimes not followed by increased building maintenance activities. Compared to the implementation of construction, which has a limited period, the preservation and utilization of the building do not have a specific lifetime. These activities will continue as long as the building is still operating. Poor building maintenance could result in the buildings cannot be used. Maintenance of the building is intended as a combination of technical and administrative measures designed to maintain and restore the function of the building as previously created (Alves et al. Júnior, 2019). Moreover, corrective action will be needed if an aspect of the building looks unfavorable.

There are two types of ongoing maintenance work: preventive and corrective maintenance (Weeks & Leite, 2022). Presidential Regulation Number 16 (2021) states, "Preventive maintenance is an activity to maintain the reliability of a building and its infrastructure and facilities so that it is always functional," usually called planned maintenance, which means avoiding damage. This type of maintenance is divided into five categories, including Time-Based Maintenance (TBM), Predictive Maintenance (PDM), Failure Finding Maintenance (FFM), Condition-Based Maintenance (CBM), and Risk-Based Maintenance (RBM) (Dhillon, 2002). On the other hand, following Presidential Regulation 16 (2021), the definition of corrective maintenance is "the activity of repairing and replacing parts of the building, components, building materials, and/or infrastructure and facilities so that the building remains functional." It is usually called corrective maintenance, which means repairs when damage occurs to put the building back into operation (Mesarosova et al., 2022). The maintenance can occur unplanned or planned.

Recently, all maintenance activities have been carried out manually in the building maintenance system. Moreover, the manual method is where the ongoing work data is still organized separately from each reparation worker. Consequently, the building maintenance team needs to conduct a thorough analysis, coupled with the possibility of missing or incomplete data. The problem also affected the quality of the building itself; prolonged defect management leads to repair procrastination which worsens the defect. For that reason, an Excel-based application system can be a system with a database that is a data recapitulation and, at the same time, a tool for issuing cost and time analysis that works well to manage maintenance and care, especially defect monitoring in buildings (Mustafa & Hatemi-J, 2022). Microsoft Excel features that can simplify big processing data include a drop-down menu, Value Look Up (VLOOKUP), and Conditional Formatting (Ramadhan et al., 2020). Previous research also shows that the Microsoft Excel function could effectively help users to solve maintenance processes by reducing the completion of maintenance reports from months to 5-10 days. The electronic program (Excel) can raise effectiveness from the technical,

managerial, and effectiveness factors (AlShaali et al., 2022; Mamaghani & Noorzai, 2023; Sallahuddin, 2013).

One of the methods used to solve maintenance problems is Monitoring Dashboard (Harode et al., 2022). A dashboard system can briefly present information on key indicators and organizational activities on one screen (Villa et al., 2021). The dashboard is an effective visualization capable of providing information at a glance (Chou et al., 2017). The maintenance team can monitor current conditions and make decisions (dos Santos et al., 2021). The dashboard has been successfully implemented in higher education (Susnjak et al., 2022), the health industry (Munbodh et al., 2022), and sustainability (Yousif et al., 2022). Defect monitoring using the dashboard can be a tool to convey damaged data to users with a summary of the data that is displayed visually and attractively so that it is easy to. In addition to the dashboard, the results that will be issued from this system are data recapitulation, time and cost analysis, references for estimated durations according to AHSP, and Gantt-chart diagrams.

A combination of techniques can be employed to address maintenance problems and optimize building management. One such approach is integrating the Monitoring Dashboard system with BPR principles. The Monitoring Dashboard provides a visual and intuitive tool for the maintenance team to monitor critical indicators and organizational activities in real-time, allowing quick decision-making based on current conditions (Villa et al., 2022). BPR can be used to reform and improve the business processes involved in building maintenance by utilizing the data recapitulation, time and cost analysis, and Gantt-chart diagrams produced from the Monitoring Dashboard. This integrated approach has been successfully implemented in various industries, such as logistics, food manufacturing, and higher education, resulting in improved performance, reduced waste, optimized resource usage, and increased labor productivity (Bhaskar & Singh, 2014). By combining the Monitoring Dashboard with BPR principles, building owners and managers can achieve more efficient, effective, and innovative building maintenance practices that align with their organizational goals and objectives.

The BPR is used in designing a system that aims to achieve improved performance by redesigning the business processes of activity. Some techniques to achieve the objectives of various BPR methods are process visualization, process mapping, change management, benchmarking, and focusing on strategy and customers (Bhaskar, 2015). BPR has been successfully applied to optimize processes such as logistics (Das, 2020), food manufacturing (Amri & Napitupulu, 2021), and higher education (Pasaribu et al., 2021). Moreover, BPR has been proven to reduce waste and optimize resource usage in manufacturing (Garcia-Garcia et al., 2021). It also increases labor productivity (Zondo, 2021). Previous research also shows that implementing the BPR could (1) increase efficiency, i.e., streamline the processes and eliminate unnecessary steps (Riyanto et al., 2018), (2) improve customer service, i.e., more responsive and effective service to customers (Harika et al., 2021), (3) increase flexibility, i.e., BPR can make the organization easier to adapt or change in the market or the business environment and (4) more significant innovation, i.e., BPR encourages the organization to rethink their processes, which can lead the new ways of doing things and breakthrough innovation. Therefore, this study was conducted by implementing the BPR to achieve the abovementioned benefit.

Although BPR has provided many benefits, adapting the system from a conventional to an application has several advantages and disadvantages. The application system simplifies the management process because the documents are more organized than the manual. All documents use cloud-drive storage on the internet to make them safer and minimize the risk of data loss. However, it has challenges for human resources and devices. Learning the application system may take a long time, especially if the user is unfamiliar with the technology. In addition, a capable device is needed to operate the application system. Not

every device can access a file; it takes a specific operating system and a high-end computer. Therefore, using Microsoft Excel as a media system is expected to facilitate the workforce in using the system. Further, the building maintenance application system can increase its workers' efficiency and productivity.

The contribution of this study is two-fold. First, we adopted a BPR-based Microsoft Excel application, which was not previously implemented in an educational building, specifically the Astra Polytechnic building. This application is a novel approach to addressing maintenance problems and improving building defect management. Moreover, to the best of our knowledge, there has yet to be any previous study that has implemented a BPR-based Microsoft Excel application in an educational building like Astra Polytechnic. The choice of Astra Polytechnic as the research site was based on its relevance to the research topic. Also, the need to explore the practical application of BPR in educational building maintenance. The condition of the building, as assessed through building defect management, provided valuable insights into the challenges and opportunities for improving maintenance processes and productivity. Our research fills this gap in the literature by providing empirical evidence of the effectiveness of BPR in the context of Astra Polytechnic building maintenance and how it can lead to increased labor productivity and improved building defect management. Second, based on the results of our research, we demonstrate that implementing our proposed solution method using BPR can increase labor productivity. These findings are supported by relevant results from previous research conducted in similar contexts, as mentioned in the previous descriptions. The paper is divided into four sections. Following is a description of the research methodology used to conduct the study. In part 3, we present the study's findings. In the final section, significant findings and insights are presented.

2. METHODS

This research has four stages of the process: System Evaluation, BPR, System Realisation, and Data Collection, as shown in Figure 1.

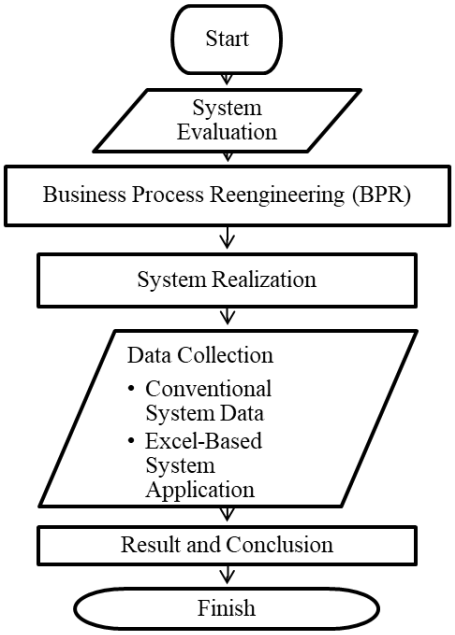


Figure 1 Research Methodology Flowchart

2.1. System Evaluation

As shown in Figure 1, the first step is System Evaluation. This stage is carried out from January 17th, 2022 – February 25th, 2022, when starting practical work activities at the Astra Polytechnic. During the study of the operating system in building damage management, several shortcomings were found, such as unscheduled repair work, damage reports not recorded/missing, or lack of media to report defects.

2.2. Business Process Reengineering

The BPR method, namely the redesign of a business process, is carried out from March 15th, 2022 – March 18th, 2022. BPRs are re-engineered to improve the efficiency and quality of damage management results. The business process that is designed must be able to answer and solve the problems that have been set. Making business process designs and system prototypes is a stage that needs to be confirmed before starting the system development.

2.3. System Realisation

The realization of the system creation was carried out in the period March 19th, 2022 – April 8th, 2022. The application system was based on Microsoft Excel with Macro-Enabled Workbook document format because all coding was written using VBA and the record macros feature.

2.4. Data Collection

The data for this study was collected using two different systems. The first system, an Excel-based application, was implemented and operated from April 9th, 2022, until June 20th, 2022, to collect data on the damage that occurred to the company. The second system involved gathering data on past damage, collected from December 1st, 2021, to December 31st, 2022, and was still used in the conventional or paper-based system. The past data was obtained during the initial internship in January 2022. The data collected from the two systems included information such as the source of crash reports, repair time, work productivity, number of data recapitulations, and scope of repair work. The collected data was then analyzed to identify patterns, trends, and insights related to the maintenance and repair processes in the Astra Polytechnic building. The analysis involved reviewing the qualitative data to identify common themes, trends, and issues related to the building's maintenance management.

The data collection process was designed to capture current and past data, allowing for a comprehensive analysis of the maintenance and repair processes and their effectiveness. By comparing data from the Excel-based application system and the conventional or paper-based system, insights could be gained into the differences and potential benefits of the proposed system. The findings from the data analysis will be presented and discussed in the subsequent sections of this paper, providing valuable insights into the effectiveness of the maintenance management system in the context of the Astra Polytechnic building.

2.4.1. *Crash Reports Data*

By using a form that can be accessed by building users, the system will record the reported damages along with the source of the report. The source of the report is the name of the person who reports the defect, along with the location of the damage that occurred.

2.4.2. *Repair Time Data*

The system will track the time a defect takes to repair. The system will count the days a defect changes status from being reported as waiting for repair until the job is done.

2.4.3. *Work Productivity Data*

Work productivity data is also provided to assist in analyzing the building maintenance team. It shows the team's performance in processing defect data and repairing the reported defects.

2.4.4. *Number of Recapitulation Data*

Data recapitulation is used in calculating the number of reported damages, the number of repairs carried out, and the number of completed damages. It used to see performance reviews from the building maintenance team.

2.4.5. *Scope of Repair Work Data*

The scope of work of this system is unlimited, as the system is used for administrative purposes. Scope of work can classify the areas of defects that occur. Knowing the areas of work that are often damaged will help the building maintenance team plan preventive maintenance.

3. RESULTS AND DISCUSSION

3.1. Result

The result presented in this research includes The conventional system business evaluation, system application work procedure, system application output, system comparison, and overall results.

3.1.1. *Conventional System Business Evaluation*

The evaluation of the conventional system includes the business process and the application of the system.

Conventional System Business Process

In monitoring, the conventional system involves the user, the General Affairs, and the technician. The following three parties cooperate and communicate using verbal and electronic messages. When the damage has been completed, no written document or data is produced other than the informal message sent when reporting the injury defect. Figure 2 below shows the business process of the conventional system.

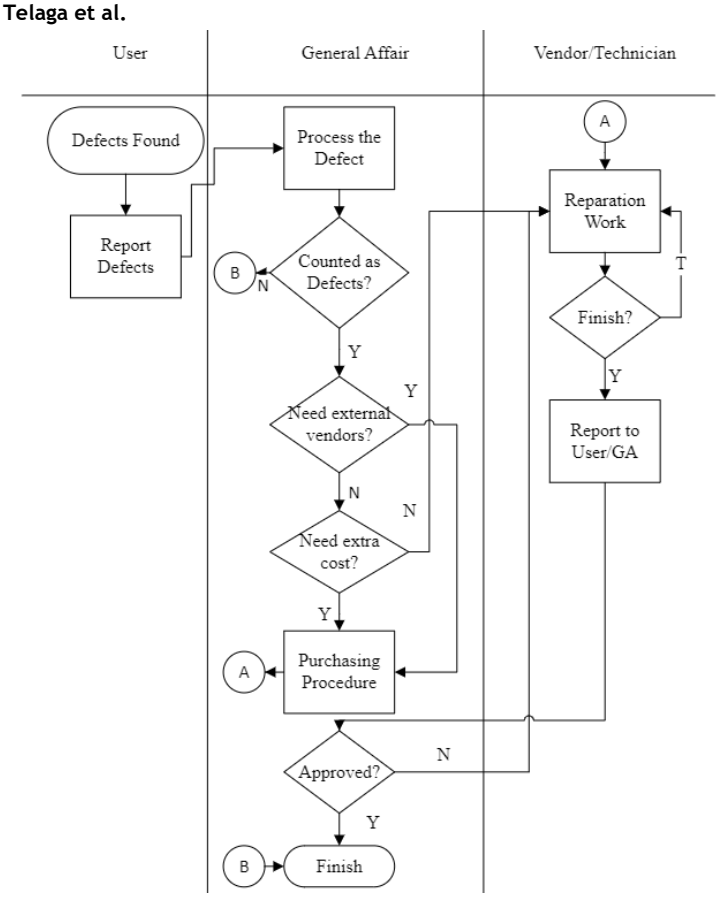


Figure 2 Conventional Business Process

System Application Business Process

After reengineering the business process, Figure 3 shows the results business process of the system application.

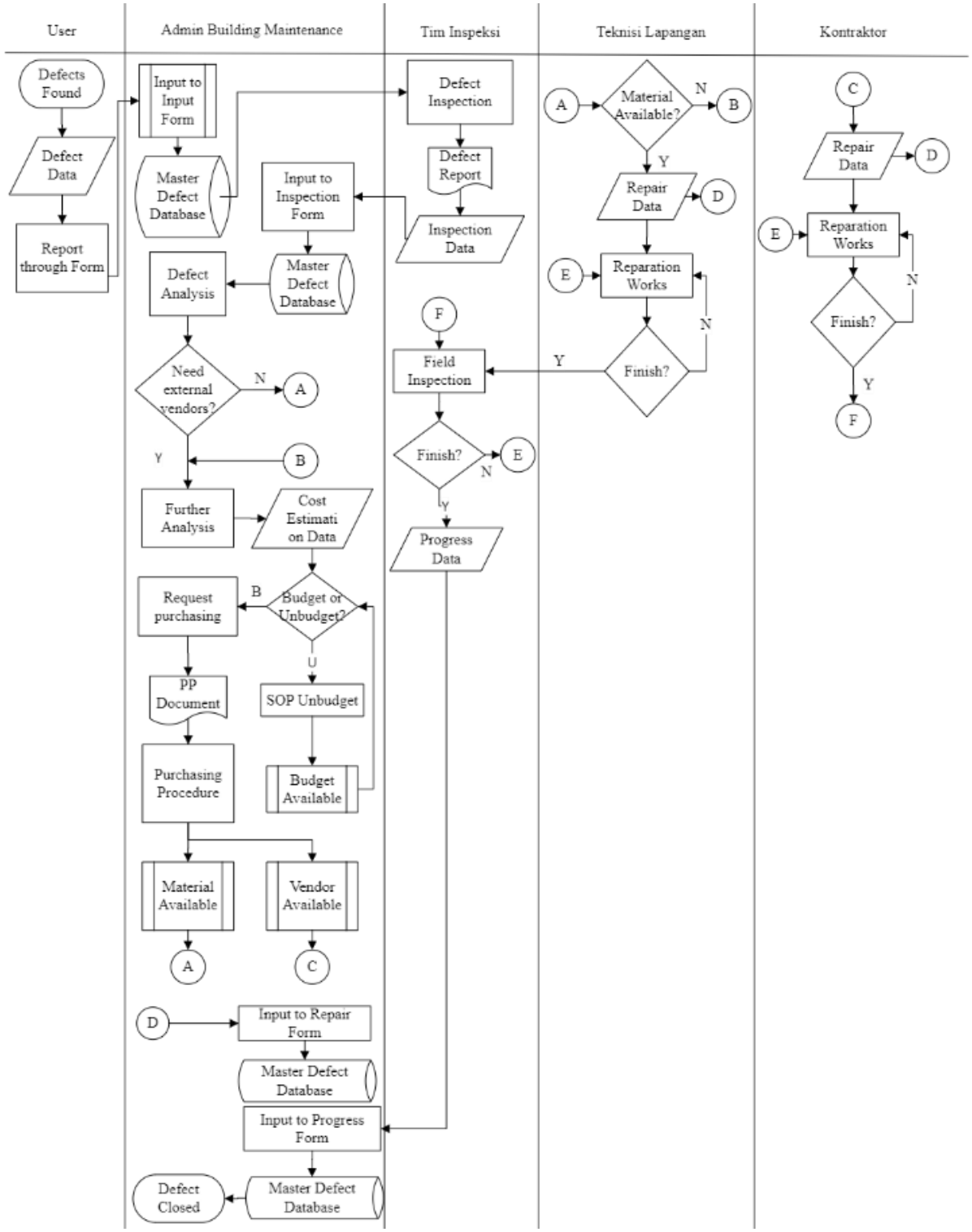


Figure 3. System application business process

3.1.2. *System Application Work Procedure*

The building maintenance gets reports and complaints of defects from various people so that the coverage of defects found is comprehensive. The administrator can use the SOP manual in operating the system. The following are the stages that are passed using an Excel-based application system.

Report Defects via Google Forms

All building users can access the link to fill out the following form, from employees to visitors. An example of the conditions is shown in Figure 4. All data filled in this form will then be accessible using the building maintenance team's e-mail and generate defect data which will then be re-selected for input into the Input Form of an Excel-based application system.

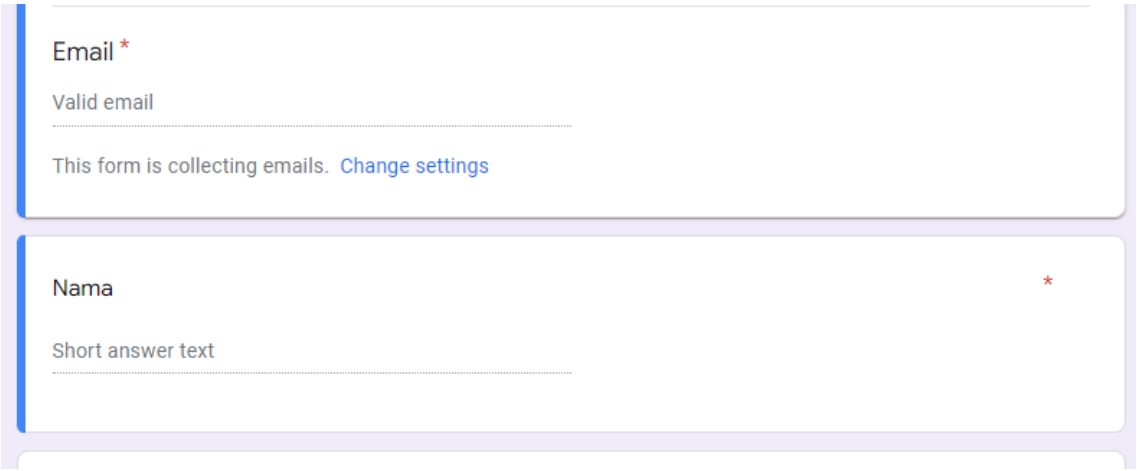


Figure 4 The Initial View of Google Forms

Input Data to Input Form in Microsoft Excel

After the input is declared a defect, the data is entered into the Input Form. This form will then be entered into the Master Defect database with the status "Waiting Inspection," their unique codes are called Defect IDs. The following Figure 5 is the input form display.

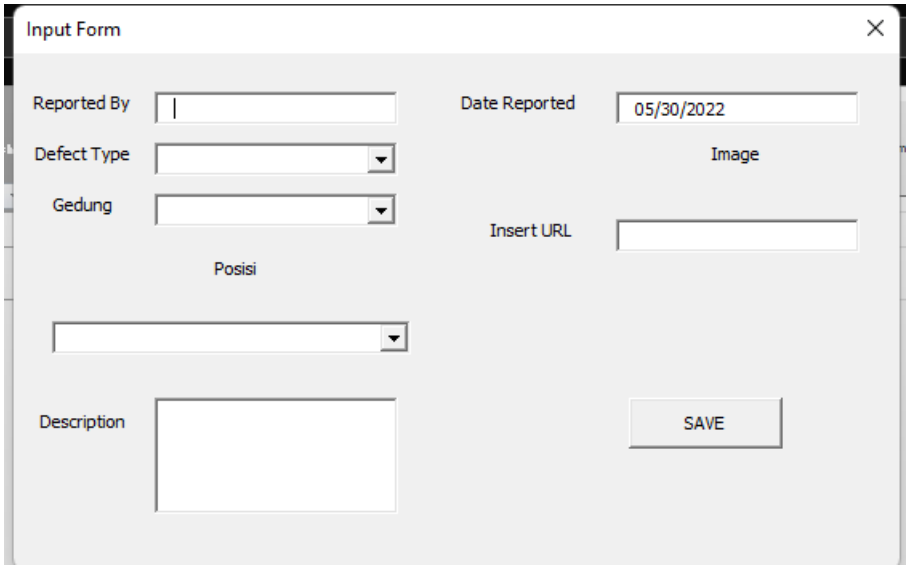


Figure 4 Input Form Display

Conduct Field Inspections with Defects Reports

The data in the database can be printed to make it easier to record inspection results. This report will have its ID or code, so it is easy to track the person in charge who carried out the inspection. This report can also later be used to check the work. The general affair building

maintenance inspection team carries out this stage. Figure 6 below shows an example of the defects reports template.

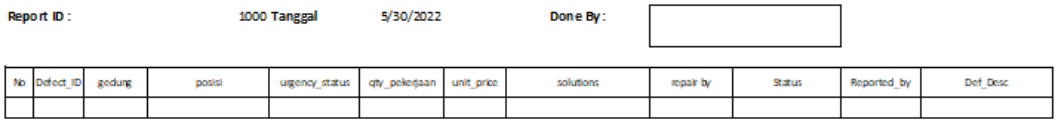


Figure 6 Auto-Generated Defects Reports

Input Inspection Data to Inspection Form in Microsoft Excel

The results of the inspection data that have been carried out are entered into the Inspection Form. By writing the Defect ID of the damage, all the data entered in the form will change the status to "Waiting Repair." The general affairs building maintenance admin again carry out this stage. The following Figure 7 is the inspection form display. The results of the inspection data that have been carried out are entered into the Inspection Form. By writing the Defect ID of the damage, all the data entered in the form will change the status to "Waiting Repair." The general affairs building maintenance admin again carry out this stage. The following Figure 7 is the inspection form display. After the Inspection Data has been successfully entered into the database, the next stage is the Building Maintenance can make decisions to find the best repair solution.

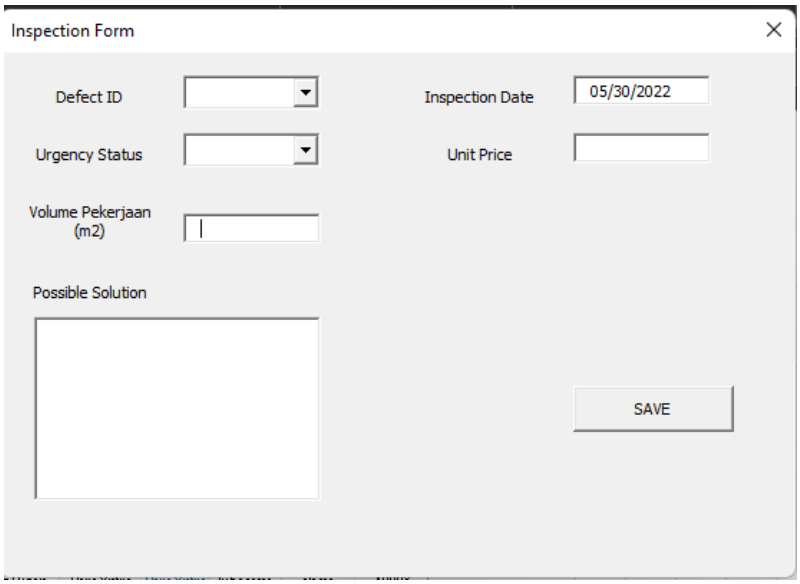


Figure 7 Inspection Form Display

Input Repair Data to Repair Form in Microsoft Excel

After getting the reparation data, an agreement was made containing the estimated start date and time needed for the damage to be repaired. The data inputted on this form will change the status to "Progress." The following Figure 8 shows the display of the repair form.

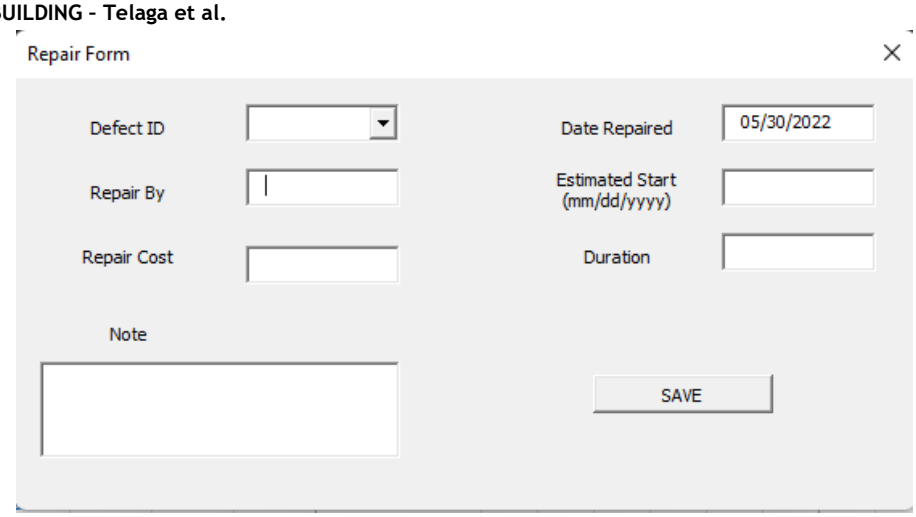


Figure 8 Repair Form Display

Input Progress Data to Progress Form in Microsoft Excel

After a defect is declared "being repaired" and in the "Progress" status, the data needed in the Progress Form is obtained from what is happening in the field. The inspection team can use the report document as a field reference to confirm. According to the defect ID of the damage, the cost data incurred can also be adjusted in the Actual Cost section. If the work has been completed, the status is changed to "finished" to declare the defect complete or closed. Figure 9 below shows the display of the progress report.

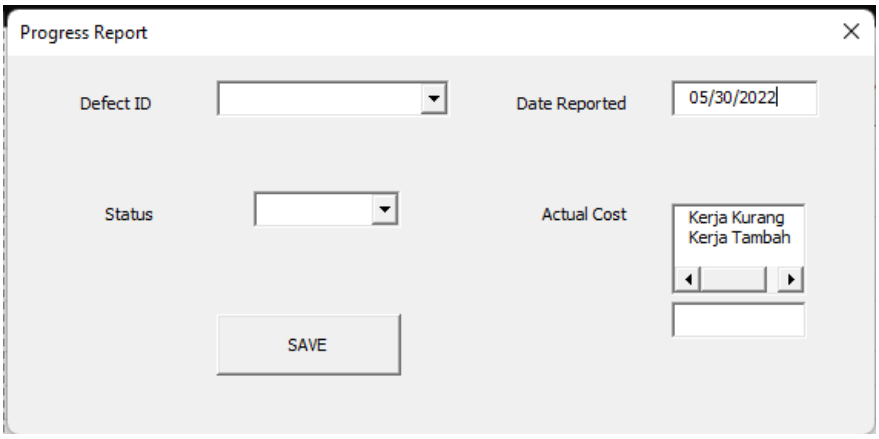


Figure 9 Display of Progress Report

3.1.3. *System Application Output*

From the Excel-based application system, not only the damaged data will not be lost, but different analysis results will be carried out to help make decisions. The results include the dashboard, cost analysis, duration analysis, duration reference, and schedule Gantt chart.

Dashboard

In this part of the page, the analysis result information is issued visually and concisely so that the user can capture the information quickly, as shown in Figure 10. The analyses published from this dashboard include the percentage of jobs by status, the quantity of work

in the system, the average time required for each stage of work, performance analysis of the building maintenance section, and planned maintenance job reminders.

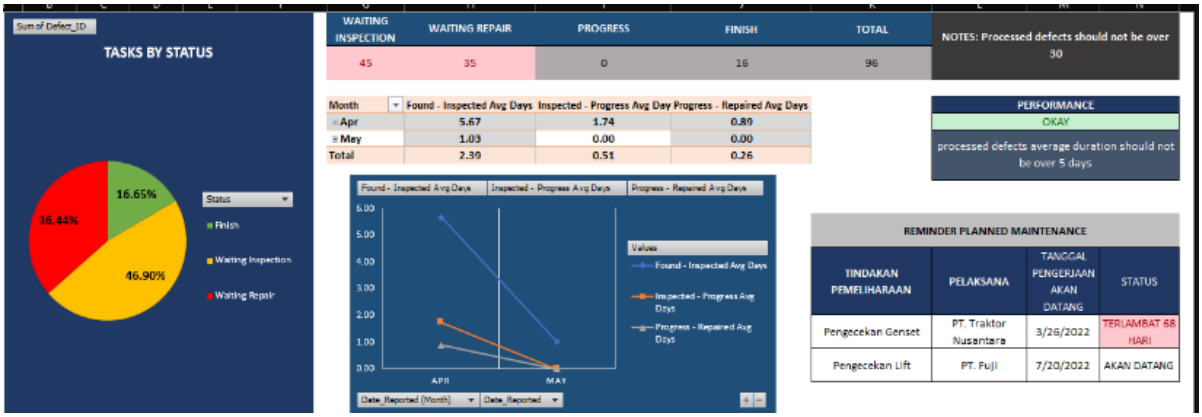
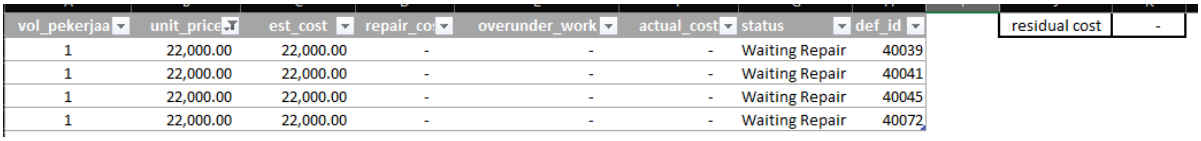


Figure 10 System Application Dashboard

Cost Analysis

With a cost analysis table, the results of the residual costs will be used for reparation planning. Figure 11 shows the display of cost analysis results.



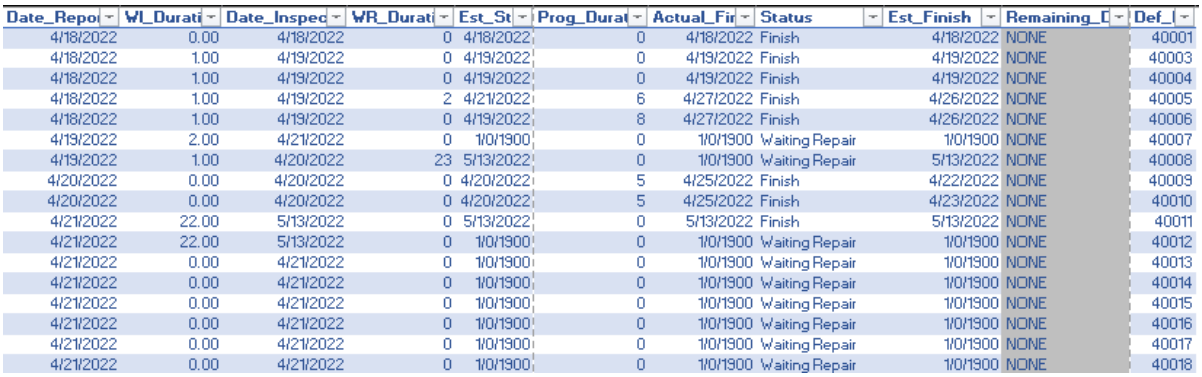
vol_pekerjaa	unit_price	est_cost	repair_co	overunder_work	actual_cost	status	def_id
1	22,000.00	22,000.00	-	-	-	Waiting Repair	40039
1	22,000.00	22,000.00	-	-	-	Waiting Repair	40041
1	22,000.00	22,000.00	-	-	-	Waiting Repair	40045
1	22,000.00	22,000.00	-	-	-	Waiting Repair	40072

residual cost	-

Figure 11 Cost Analysis Results

Duration Analysis

To see the "remaining work duration" and "ongoing work delays," the duration analysis page can show the results in the "Remaining_Days" column, as shown in Figure 12.



Date_Repo	WI_Durati	Date_Inspec	WR_Durati	Est_St	Prog_Durat	Actual_Fi	Status	Est_Finish	Remaining_D	Def_I
4/18/2022	0.00	4/18/2022	0	4/18/2022	0	4/18/2022	Finish	4/18/2022	NONE	40001
4/18/2022	1.00	4/19/2022	0	4/19/2022	0	4/19/2022	Finish	4/19/2022	NONE	40003
4/18/2022	1.00	4/19/2022	0	4/19/2022	0	4/19/2022	Finish	4/19/2022	NONE	40004
4/18/2022	1.00	4/19/2022	2	4/21/2022	6	4/27/2022	Finish	4/26/2022	NONE	40005
4/18/2022	1.00	4/19/2022	0	4/19/2022	8	4/27/2022	Finish	4/26/2022	NONE	40006
4/19/2022	2.00	4/21/2022	0	1/0/1900	0	1/0/1900	Waiting Repair	1/0/1900	NONE	40007
4/19/2022	1.00	4/20/2022	23	5/13/2022	0	1/0/1900	Waiting Repair	5/13/2022	NONE	40008
4/20/2022	0.00	4/20/2022	0	4/20/2022	5	4/25/2022	Finish	4/22/2022	NONE	40009
4/20/2022	0.00	4/20/2022	0	4/20/2022	5	4/25/2022	Finish	4/23/2022	NONE	40010
4/21/2022	22.00	5/13/2022	0	5/13/2022	0	5/13/2022	Finish	5/13/2022	NONE	40011
4/21/2022	22.00	5/13/2022	0	1/0/1900	0	1/0/1900	Waiting Repair	1/0/1900	NONE	40012
4/21/2022	0.00	4/21/2022	0	1/0/1900	0	1/0/1900	Waiting Repair	1/0/1900	NONE	40013
4/21/2022	0.00	4/21/2022	0	1/0/1900	0	1/0/1900	Waiting Repair	1/0/1900	NONE	40014
4/21/2022	0.00	4/21/2022	0	1/0/1900	0	1/0/1900	Waiting Repair	1/0/1900	NONE	40015
4/21/2022	0.00	4/21/2022	0	1/0/1900	0	1/0/1900	Waiting Repair	1/0/1900	NONE	40016
4/21/2022	0.00	4/21/2022	0	1/0/1900	0	1/0/1900	Waiting Repair	1/0/1900	NONE	40017
4/21/2022	0.00	4/21/2022	0	1/0/1900	0	1/0/1900	Waiting Repair	1/0/1900	NONE	40018

Figure 12 Duration Analysis Display

Duration Reference

The function of the duration reference is to estimate the duration of completing a job. On this page, two aspects can influence the workforce needed and the deadline for the work to be completed. The Excel-based application system will use the SNI 2022 work coefficient as a reference for calculating the duration. Figure 13 below shows an example of duration reference.

DURRATION REFERENCE (AHSP 2022)

PEKERJAAN	KOEFISIEN
Pembongkaran 1 m3 Dinding Tembok Bata	0.667
Penggalian Tanah Biasa Sedalam s.d 1 meter untuk volume s.d 200 m3	0.75
Pemadatan Tanah 1 m3 per 20 cm dengan Timbris	0.5
Pembuatan 1 m' Pagar Sementara dari Kayu Tinggi 2 Meter	0.4
Pekerjaan Normatif *Dewatering* 1 buah kistdam pasir/tanah dibungkus karung plastik bagor 43 x 65cm	0.04
Pengeboran Sumur Air Tanah Dangkal diameter 1" - 1.25"	0.15
Pengadaan dan Pemasangan Pompa dan Perpipaan *Reducer*	0.225
1m3 Pasangan batu kosong yang teratur dan padat-sedikit rongga; beda tinggi > 0 s.d. 1m'	0.8
Pekerjaan 1 m2 Pasangan batu muka dan batu candi	0.24

Perhitungan menentukan durasi

Volume Pekerjaan	50
Manpower	5
Total Produktivitas	1.167
Estimated Duration	**11.67**

Perhitungan menentukan tenaga kerja

Volume Pekerjaan	20
Durasi	5
Total Produktivitas	1.917
Estimated Manpower	**7.668**

Figure 13 Duration Reference

Time Schedule Gantt Chart

This Gantt chart model is used to make it easier to check the duration of a job. With this page, actual performance data can automatically be generated as a Gantt chart. The following Figure 14 shows an example of a Gantt chart diagram.

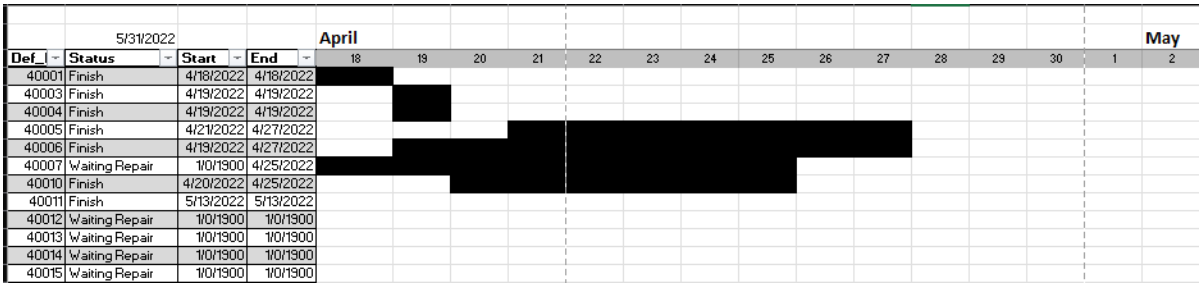


Figure 14 Schedule Gantt Chart

3.1.4. *System Comparison*

In conclusion, there are many differences between the conventional system and system applications. Table 1 below summarises the comparison of the two methods.

Table 1 System Comparison

Comparison	Conventional System	Excel Based Application System
Business process	The business process only involves building users, general affairs building maintenance, and vendors.	The business process involves five parties: building user, admin building maintenance, inspection team, field technician team, and vendors.
Job desk	The building maintenance parties are merged into the same job desk.	Building maintenance is divided into three job desks: enter data into the system, field inspections, and repair defects.
Procedure	Using verbal, short messages, and print-out defect lists from vendors.	Google Forms is used to hear complaints from building users and forward the data into an Excel-based application system.
Output	Defect list sheet from the vendor.	Cost analysis, duration analysis, dashboard, duration estimation reference, and schedule Gantt Chart.

3.1.5. *System Results*

An Excel-based application system is used to improve the quality of building maintenance management. Building maintenance quality and delivery can increase with an application system to manage the damage. Observations of conventional systems were based on data obtained in December 2021, while application trials were carried out from April 13th, 2022 – May 13th, 2022.

Source of Reports

This point is critical to ensure all building users have access to report any defects found. The more open access for users to report damage, the more excellent the opportunity for building maintenance to find out where the injury occurred in the building. After the system operates, additional sources of damage reports are obtained, namely students who occupy dormitories.

Process Duration

The duration can conclude the performance of the building maintenance section it takes to repair the damage. One of the goals of this system is to speed up the time of repair of injury while simultaneously increasing the performance of the building maintenance section. Below in Table 2 are the results of the duration analysis issued on the dashboard. From these results, it can be concluded that the total average duration required for a defect found to be resolved 18.85 days or 19 days. The time of the repair work to completion is included in the technical field. Therefore, the data listed only applies to low damage or finishing levels. In the conventional system, the average time needed is about 20 days based on observation, evidence, action, and testing.

Table 2 Application system duration analysis

Month	The average duration of damage discovered to inspection (days)	The average time of damage inspection to completion (days)	The average time of repair work carried out to completion (days)
April	7.74	3.22	0.89
May	14.57	7.00	0.10
Total	12.61	5.91	0.33

Workforce Productivity

Productivity points are critical in assessing the performance of a job. Seeing the condition of conventional systems and application systems that have different parameters for the number of workers and total duration, the formula used to determine worker productivity is shown in formula (1):

$$Workforce\ Productivity = \frac{Total\ Workers}{Total\ Duration} \quad (1)$$

The formula is adapted to conventional system data and application systems to produce the following information, as shown in Table 3.

Table 3 Workforce productivity comparison

System	Total Workers	Total Duration	Productivity
Conventional	3	20	0.15
Application	4	19	0.21

Defects Recapitulation

This point represents the amount of damage reported during the period. Data recapitulation is needed for administrative data collection and further decision-making. With the recapitulation of defects data, it is possible to find a malfunction repeatedly occurring in the same place and see what actions have been taken. In a period that is approximately equal to 30 days, the following two systems accumulate a relatively small number of failures, 46 failures for conventional systems and 52 failures for application systems. The differences can be affected due to the traditional design. The new building is starting to operate so that only construction errors are found. Meanwhile, defects to the application system are human errors or damage due to building users.

Cost Savings

In the realization of implementing an Excel-based application system for building maintenance management, the significant result lies in the duration of the performance of each cycle. The flow of execution of each damage management process is as follows, assuming 100 defects are found—the calculation of cost savings between the system is shown in Table 4 below:

Table 4 Cost savings results

System	Stages	Time	Total Duration	Information
Conventional	Going around the building looking for defects	480'	960'	assuming 100 recapitulation data/week
	Recapitulating damage data reports with Excel tables manually	480'		
Excel system	Entering the damage from the report form into the Excel system	180'	185'	
	Recapitulate the damaged data into a table and ready to print	5'		
Comparison				
Bekasi Regency Minimum Wage Conversion 2022			Rp. 526.65	/minute
Rp. 5,055,874.60/month				
Conventional system worker wages			Rp.	/week
960 minutes/week			505.587.46	
Excel system worker wages			Rp. 97,430.25	/week
185 minutes/week				
Reduction of labor wages			Rp.	/week
/person			408,157.21	
Net Quality Income			Rp.	/month
Four weeks/month			1,632,628.84	
Net Quality Income			Rp.	/year
12 months/year			19,591,546.1	

3.2. Discussion

Based on the results shown in the previous section, the implementation of Net Quality Income analysis (NQI) produced by an Excel-based application system for building maintenance management purposes, an excel-based application system can significantly improve the quality and efficiency and speed up the duration of the maintenance damage search process compared to the improvements are made by 5% the time of damage handling with the conventional system. In terms of business processes and methods, the data obtained shows BPR's benefit, as previously explained. The conventional system involves the building user, general affairs building maintenance, and vendors. In contrast, the Excel-based application system involves five parties: the building user, admin building maintenance, inspection team, field technician team, and vendors. It indicates that the application system has a more complex but well-defined business process that includes clear roles and responsibilities for each party involved. It can help streamline the maintenance process and ensure all necessary steps are followed, leading to more effective and efficient maintenance management.

Regarding the job desk, the building maintenance parties are merged into the same job desk in the conventional system. In contrast, labor productivity increased by 32.2% in the available workforce, from 0.15 to 0.21; after using an Excel-based application system, the building maintenance is divided into three job desks, which include entering data into the system, field inspections, and repairing defects. This division of job desks allows for better specialization and focus on specific tasks, leading to improved performance and accountability. It also enables better coordination and collaboration among the different teams involved in the maintenance process (Zondo, 2021). It also increases efficiency by eliminating unnecessary steps and speeds up the damage recapitulation by up to 12 hours per maintenance cycle (Riyanto et al., 2018).

The conventional system relies on verbal and short messages and vendor print-out defect lists. In contrast, the Excel-based application system uses Google Forms to hear complaints from building users and forward the data into an Excel-based application system. It indicates that the application system utilizes modern technology to streamline the data collection and ensure accurate and timely reporting of defects. Google Forms also allows for easy access to defect reporting by all building users, including employees and visitors, leading to increased reporting and better coverage of defects found in the building. The output of the conventional system is limited to a defect list sheet from the vendor.

In contrast, the Excel-based application system provides various output options, including cost analysis, duration analysis, dashboard, duration estimation reference, and schedule Gantt chart. It indicates that the application system provides a more comprehensive and detailed analysis of the maintenance process, allowing for better decision-making and monitoring of the progress of repairs. The availability of different types of analysis also enables the building maintenance team to identify areas for improvement and make data-driven decisions to optimize the maintenance process.

Implementing the Excel-based application system has several benefits for building maintenance management. Firstly, it allows for more comprehensive and accurate defect reporting, as all building users can easily report defects, leading to improved coverage of defects found in the building. Secondly, the division of job desks and specialization of tasks in the application system leads to improved performance and accountability among the maintenance teams. Thirdly, using modern technology in the form of Google Forms and Excel-based application systems streamlines the data collection process and ensures accurate and timely reporting of defects. Finally, the availability of various output options for analysis in the application system enables better decision-making and monitoring of the maintenance process. It is important to note that the observations and trials of the application system were

conducted within a specific timeframe from April 13th, 2022, to May 13th, 2022. Further long-term monitoring and evaluation of the application system's performance are recommended to assess its sustainability and effectiveness in the long run. Additionally, user feedback, including the building's users, general affairs building maintenance, inspection team, field technician team, and vendors, should be collected and incorporated into the system's improvement process.

4. CONCLUSION

Based on the results of the Net Quality Income analysis (NQI) produced by an Excel-based application system for building maintenance purposes, an Excel-based application system can speed up the duration of the damage search process improvements made by 5% of the time damage handling with conventional methods. Moreover, the system also speeds up the course of damage recapitulation by up to 12 hours per maintenance cycle. With the available workforce, labor productivity increased by 32.2%, from 0.15 to 0.21, after using an Excel-based application system. The Excel-based application system provides a dashboard that shows the percentage of work based on status, the quantity of work recorded by the system, the average time for each stage of the career, performance analysis of the building maintenance team, and reminders of planned maintenance work. Compared to the previous study shows that Business Process Reengineering (BPR) methods in an educational building can also increase efficiency, improve user experience, and increase flexibility. Before creating a new system, it is recommended to consider several factors, such as the choice of application, devices, and the worker's ability. The technology of the system is the least concern of BPR Implementation.

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