Enhancements to Human Resource and Data Resource Management Performance in the Development of Disc Brake Pad Products

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Abstract. *The brake friction material sector is impacted by severe competitiveness, continuously changing client needs, and very precise customer specifications. As a result, precise design and quick development are techniques to increase competitiveness. Cross-functional work approaches are complex and generate product development delays. In addition, resource management in cross-functional work, such as handling huge amounts of information and various participants, is critical for a corporation. This study aimed to enhance resource management performance by separating activity into two segments. First, the project management efficiency in a new model development process was improved by deploying a program for displaying work status, which was a project management program. Second, by establishing the product development program on a web application platform utilizing MySQL, the data collection procedure is being improved. Following execution, a project management program can improve team project management efficiency. It satisfied managers at a very satisfactory level with a mean of 4.33 out of 5 and staff at a good level with a standard of 4.09 out of 5. Moreover, the product development program can improve the data collection process by 5.72% reducing the working time of the disc brake pad product development process, 24.53% reducing the time required to input the sample test data, and 60% reducing the time required to search for the sample test data. Managers and employees were both extremely satisfied, scoring 4.25 and 4.24 out of 5 points, respectively.*

Keywords:
project management, database system, brake friction material, product development.

1. Introduction

The current situation of the global industry has been pushed by industry 4.0 policy and digital technology to improve competitiveness, such as lowering manufacturing costs, enhancing product quality, and adopting flexible production [1]. Also, the increasing competition or the rapidly changing and highly specific requirements of customers are factors that affect the organization. In addition, the approach to enhancing competitiveness and product development capability, such as accurate design, rapid development, facing technical challenges, and intense competition, is applied in an organization, but the background working method of the organization, cross-functional work, decreases the efficiency of work. The various resources that are engaged in a team, and the necessity of collaboration across departments, cause delays and complexity in work [2]. Cross-functional work is a working method of collaboration between many resources in a team and across departments; therefore, resource management is essential. Also, the alignment of industrial 4.0 policy, the development of corporate innovation, and resource management in an organization by using digital technology was found to assist resource management, make better project decisions, and enhance sustainable competitiveness [3]. An example of using digital technology for human resource management in an organization is the use of ready-to-use software such as Kanban Online Board to visualize the workflow overview, task status, and job description, which can improve team member collaboration [4]. Also, an example of using digital technology for managing data in an organization is the development of web applications for data management by using React, NodeJS, and MySQL software, which was found to be feasible and efficient [5]. From 2014 to 2016, the deployment of a quality system in a large Chinese heavy vehicle found that it assisted in increasing the revenue of the organization by 181.86 million yuan in total, assisted in energy and environmental conservation, assisted in improving manufacturing performance, assisted in saving manufacturing costs, and helped in decreasing quality loss [6]. Also, the use of less complex project management software, such as MS Project and Primavera programs, to show the period of the task, resource and risk information, and interaction between project teams found that it has an average rating of acceptability in Croatian enterprises. Small businesses and

small-scale projects that do not use support software have statistically significant related values [7]. Furthermore, the implementation of new information models for the acquisition of product information and knowledge (I & K), such as the model of each case product development and the model of all case product development in a brake system friction material development at a Brazilian brake lining manufacturer found that this technique aids in the treatment of specific knowledge of each cycle development process and allows engineers to make preliminary decisions for future product development [8]. Moreover, the implementation of the Product Range Model (PRM) concept, combined with the rule-based systems and the case-based reasoning system, and developed with computational approaches, assists decision-making processes in product development. For injection molded products, a knowledge-based system approach is a linkage between possible solutions and limitations. For friction materials products, a case-based reasoning method is a relationship in terms of cases such as experimentation linked with formulation, manufacturing processes, and testing. After deployment, the product information model collaborates with expanded knowledge models, and it is found that this assists in decision-making throughout the product development cycle [9]. In addition, the development of a back-end database website in automation type for the website of the Nottingham University library using MySQL software and the PHP language found that the database is popular among library staff and users, easy to maintain, valuable for information skills training and inquiry work, and the user appreciates the one-stop-shop approach of excellent information resources [10]. Then, the analysis and design of a large and complex database are performed using the normalization method for forming databases and using the MySQL Workbench software for database facilitation. After implementing the normalization method for designing manpower information systems in Indonesia, they discovered that the procedure of normalization is essential in the design procedure and aids in producing a good, efficient, and rapid database [11]. The development of a Web-based database of rapeseed-mustard plant genetic resource data for varietal development in India using the Linux-Apache-MySQL-PHP (LAMP) platform for users able to search and access information in the database dynamically and in actual. After launching, the Rapeseed-Mustard Plant Germplasm Information System (R-MPGIS) was user-friendly, capable of being used by many people, accessible from anywhere, updatable by authentic users, and capable of assisting in locating alternative sources of rapeseed-mustard germplasm by identifying accessions with specific traits [12]. Project management software can improve resource management effectiveness. Information management and database development methods can improve data accessibility for making product development decisions, such as interactively searching or locating information in a database in real-time. The MySQL database and phpMyAdmin are used in the work on application development for management information in the refrigerator manufacturing process. Researchers observed that it can enhance staff's working performance, minimize working time, and reduce organizational losses after deployment [13]. It can improve operational efficiencies, such as teamwork, process coherence, punctual process, and company performance, with a 5-8% excess loss [14].

The manufacturing of brake friction materials (a case study) is affected by intense competition, delays, and complexity. Therefore, the resource management approach is important for the product development method. At present, each employee is working on 2-3 projects at the same time in the new model development. The distinction between each project is the stage in which it is currently operating. Furthermore, employees must collaborate with participants from 3-5 cross-functional teams. Project participants must be kept up-to-date on the status of their work in order to plan and manage their activities and respond quickly to client requests. As a result, work for the creation of a product that meets client requirements must be managed and planned. Thus, in order to improve project management efficiency, staff in an organization must use a project management application. Additionally, in each formulation development process, a considerable quantity of data, diverse types of data, and multiple formats from team members are exchanged for the operations and to manage a formulation development project. Employees gather 500 MB of data every month per project to be input for conducting the formulation development process throughout the real activity of the formulation development process. After completing the formulation development process, teams summarize and gather 250 MB of data every month per project. There are two sorts of data gathering methods: data gathered on a data server on each department's computer and data collected in hard copy. The files on the computer server include documents, PowerPoint files, Excel files, PDF files, image files, and SQL files. The multiplicity of file sorts from the data on the computer server makes searching and summarizing for analysis during the formulation creation process difficult. It can only be searched and viewed by the data owner. Moreover, physical data takes up a lot of storage space and is difficult to discover without a suitable table of contents management system. As a result, an efficient data collection method is required for a business. Thus, resource management, such as data and team member management, is necessary for the product development process. For this reason, this research explores programs for visualizing the status of work in cross-functional teams to manage projects more effectively as well as improve data collection systems and programs to develop products more conveniently.

The working status program is developed using the following steps: First, examine the work structure, human resources, and supporting papers. Second, to select the program that is appropriate for use. Third, to implement a tracking work status program in the new model development process. Finally, to evaluate customer satisfaction. The product development program is developed using the steps as follows: First, study the work organization, human resources, and relevant documentation. Second, to design

flow data that is essential for the formulation development process and that must be gathered in a database. Third, to develop the product development program, a database program for collecting and retrieving data; and fourth, to implement a database program in the formulation development process. Finally, to evaluate customer satisfaction and time after the implementation of the product development program.

2. Methodology

2.1 Study company background

The product development process of the disc brake pad product is divided into two main parts: new model development and formulation development. Therefore, this research study about the work structure, human resources, and related documents in the request for a sample product method of the new model development process found that work occurs with delays. As in one month of work, each employee is working on 2-3 projects at the same time in the new model development. Each project is distinguished by its current operation. Furthermore, employees must collaborate with members of 3–5 cross-functional teams. Project participants must be constantly informed about the state of their work so that employees can plan and manage their activities and respond rapidly to customer requirements.

The customer needs identification method, the feasibility analysis method, the plan and define project details method, and the build and test experimental sample method of the formulation development process found that data and documents are gathered in several places, from a range of team members and across departments, making it challenging to obtain data for design and development rapidly. Every month for each project, 500 MB of data is collected to be used in the formulation development process, and 250 MB is summarized and gathered at the end. Data exists in many forms, including papers, PowerPoint files, Excel files, PDF files, image files, and SQL files. The variety of file types in the data on the computer server makes searching and summarizing for analysis during the formulation production process challenging. Information can only be accessed and searched by the data owner. Furthermore, physical data consumes a lot of storage space and is difficult to locate without an appropriate table-of-contents management system.

2.2 Method selection

2.2.1 Determine the programs for visualizing work status.

Study how to utilize basic functionalities of the program for use in projects, such as the calendar board function, Gantt chart function, or preview overview project function. After that, investigate the technique to enter information into the system, such as work structure, human resources, and related documents. Then, a program is deployed to track the work status of staff and manager users on the requirements sample product method of the new model development process.

2.2.2 Develop product development programs for data collection.

The method of system development includes five steps. First, the researcher investigated the data consumption function and data relations of the formulation development process. Second, the researcher develops a system process flow diagram and designs data flow in a context diagram perspective to explain the overall system and the relevance of the main data and users. The system operation steps are designed to be utilized by various people and to collect data from several processes. Figure 1 depicts a process flow diagram view of the system operation step. The data flow diagram view, the overall system, and the relevance of main data with users in the customer need identification method, the feasibility analysis method, the plan and define project details method, and the build and test experimental sample method are designed to cover all data. Figure 2 shows an example of a data flow diagram in context diagram view. Third, create a data flow diagram at levels 0, 1, and 2 to represent the details of users, workflow, data storage, and data flow. After that, the researcher compiles the data from the working process that would be stored in a database, normalizes the data into normal form, and creates a data connection of data in the entity-relationship diagram view (ER-diagram). Next, develop a product development program using the Adobe Dreamweaver 2021 program by utilizing the PHP language to monitor the functioning of the website, the SQL to handle relational data, the HTML to express and specify the website structure, and the CSS to manage the style of website content. Then, a product development program is installed on the company's server and deployed in the formulation development process.

2.3 Implementation

2.3.1 Utilize the programs for visualizing work status.

The detail of data in the request a sample product method of the new model development process, for example, process name, process time, responsible persons, documents, and process conditions are entered in the Proof Hub program for visualizing work status. After that, team members will be trained in how to utilize the software, and the program will be tested in the workplace for one month. Figure 3 presents an example of a program for visualizing work status. A report project view shows project information such as project progress, responsible person, total task information, and others, as shown in Figure 3(a). A Kanban board view shows the information on cards on the board, such as the responsible person, note, date, status of each task, and others, as shown in Figure 3(b). A calendar view shows timeline information for each task on the calendar, as shown in Figure 3(c). A Gantt chart view shows the project information on a Gantt chart, such as task name, duration of each task, progress, start and due date, and others, as shown in Figure 3(d)

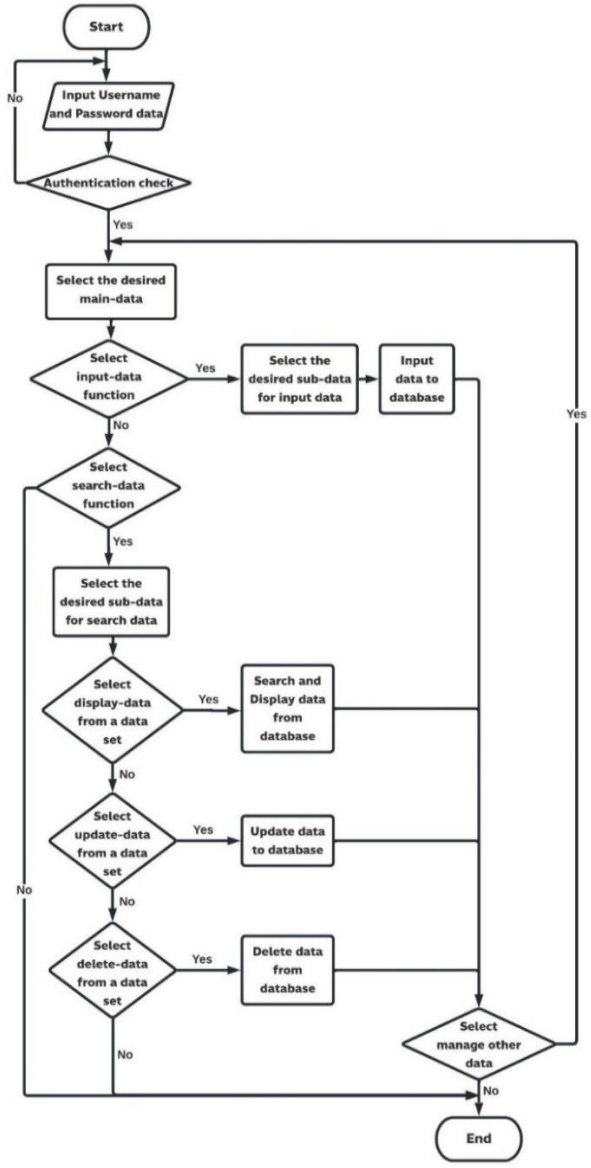

Fig. 1 The process flow diagram of a product development program.

2.3.2 *Utilize the product development program.*

After developing the program from a data flow and process flow diagram on the Adobe Dreamweaver 2021, this program was used in the formulation development process. Figure 4 presents an example of the main function pages in a program. The input data page shows the page format for inputting each data set and the method of entering data into the program, as shown in Figure 4 (a). The display data page shows the page format when browsing data, as shown in Figure 4 (b). The Deleted data page shows the page format for deleting each data set and the page format when browsing for managing data, as shown in Figure 4 (c). The update data page shows the page format for inputting data for the updated data into the database, as shown in Figure 4 (d).

2.4 Evaluate the results after implementation.

2.4.1 Evaluate employee satisfaction.

This research collects personal information and employee satisfaction data in the product development process at a brake friction materials company by performing a survey and using a questionnaire tool. A program for visualizing work status has been implemented by the new model development project team. This team consists of 17 members. After using a program to track work status, 17 people on the new model development project team evaluated their satisfaction after using the tool. The topics that are used for satisfaction assessment after using the program are divided into two parts: At the manager level, the implementation of the work status tracker system aids in the better management of the team's work activities; the implementation of the work status tracker system aids in the better management of human resources; and the implementation of the work status tracker system aids in better project management. At the staff level, the implementation of the work status tracker system makes team coordination easier; the implementation of the work status tracker system assists in the management of work activities; the implementation of the work status tracker system assists in the management of working time; the implementation of the work status tracker system provides for a more systematic operation; and the implementation of the work status tracker system can be used to maintain track of work activity data. Table 1 presents a form for evaluating satisfaction after using the program for visualizing work status.

Table 1 The form for evaluating satisfaction after using the program for visualizing work status.

Question	Satisfaction level				
	1	2	3	4	5
For manager level					
1.) The implementation of the work status tracker system aids in the better management of the team's work activities.					
2.) The implementation of the work status tracker system aids in the better management of human resources.					
3.) The implementation of the work status tracker system aids in the better project management.					
For staff level					
1.) The implementation of the work status tracker system makes team coordination easier.					
2.) The implementation of the work status tracker system assists in the management of work activities.					
3.) The Implementation of the work status tracker system assists in the management of working time.					
4.) The implementation of the work status tracker system provides for a more systematic operation.					
5.) The implementation of the work status tracker system can be used to maintain track of work activity data.					

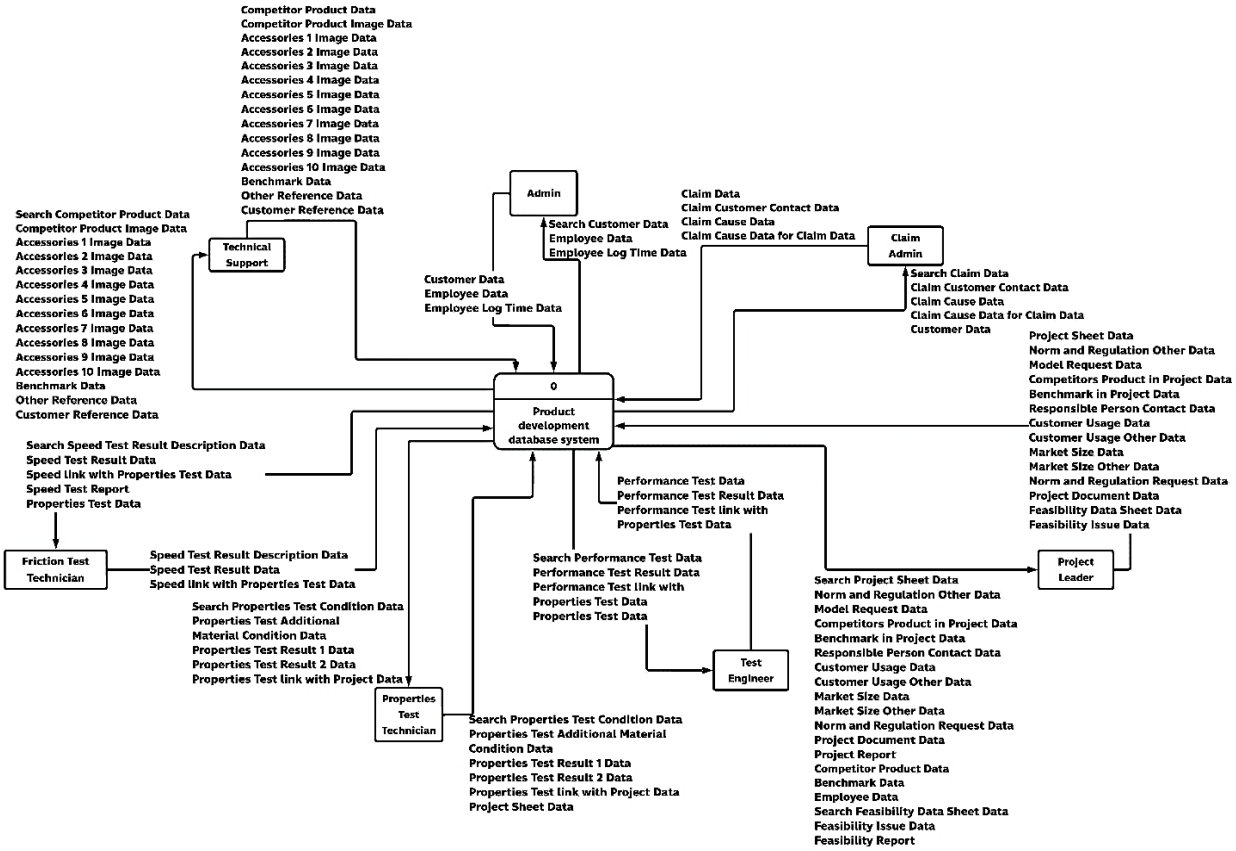

Fig. 2 The data flow diagram in context diagram view.

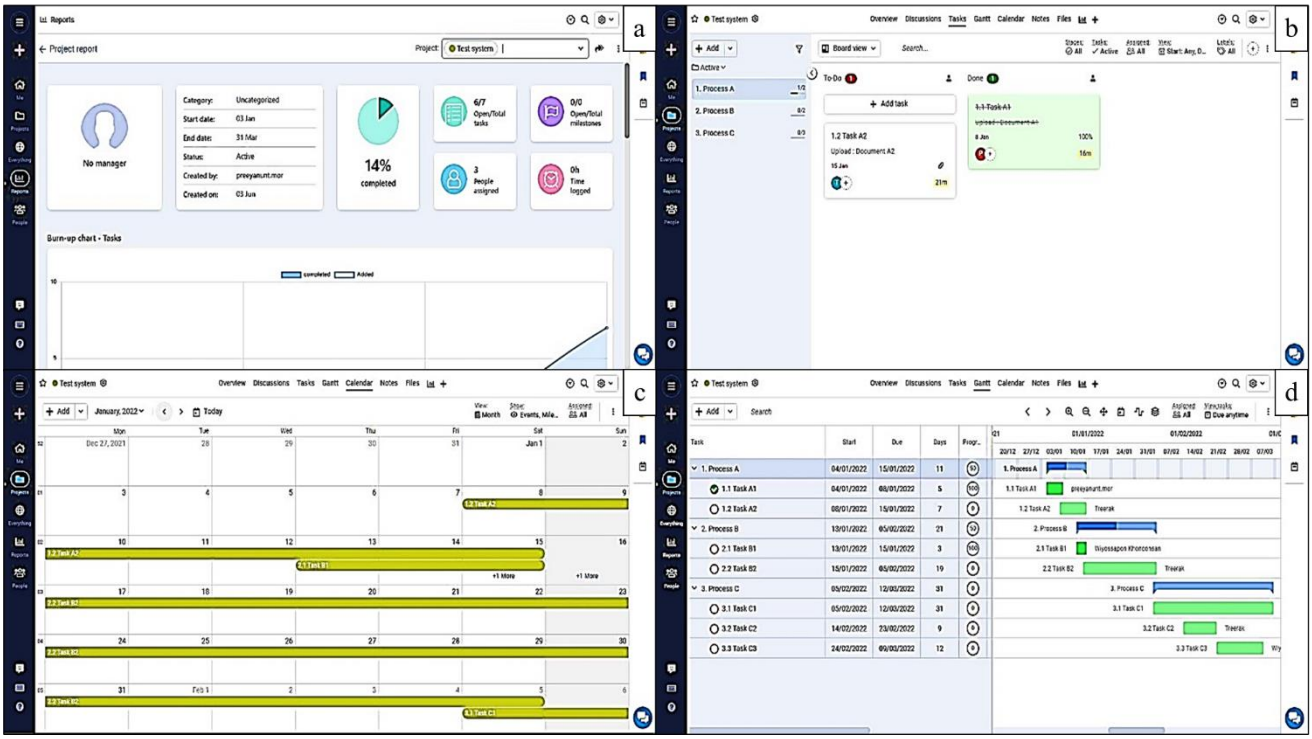

Fig. 3 The example screenshots of a program for visualizing work status consists of (a) report project view, (b) Kanban board view, (c) calendar view, and (d) Gantt chart view.

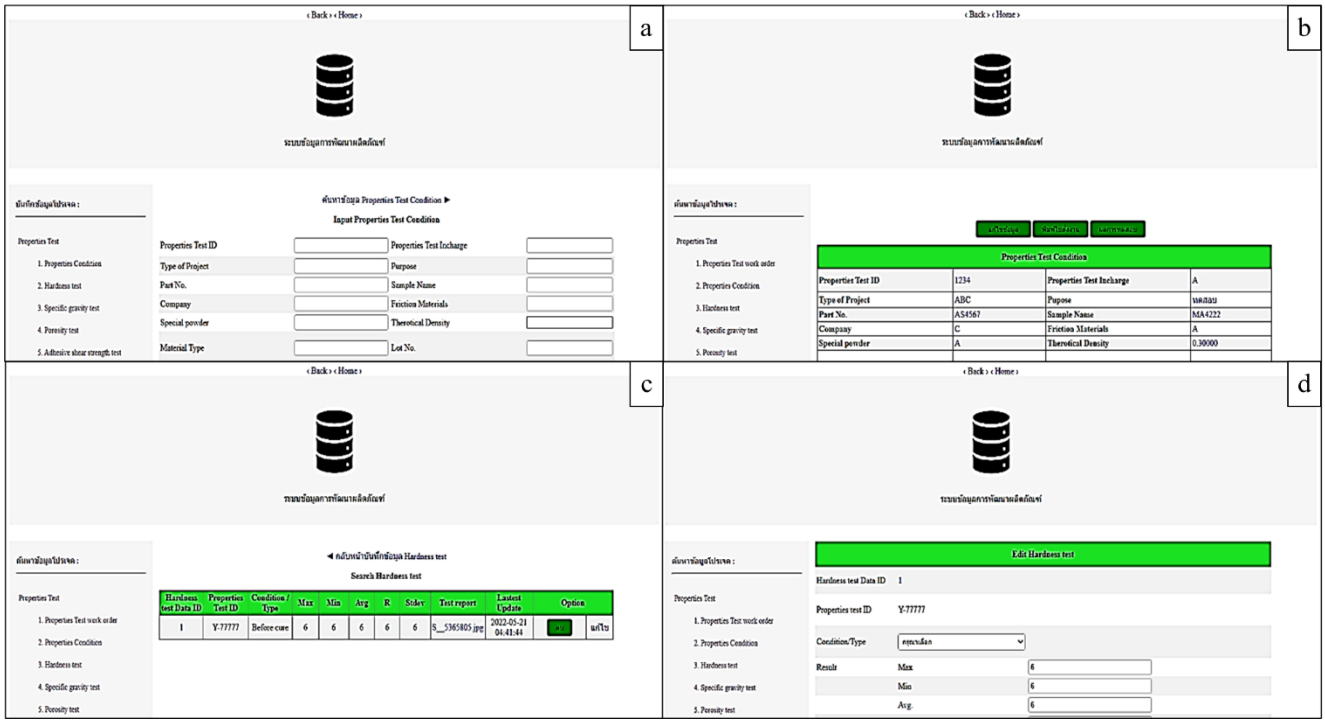

Fig. 4 The example screenshots of the main function pages in the product development program consists of (a) input data page, (b) display data page, (c) delete data page and (d) update data page.

The systems and programs for data collection have been implemented by the customer need identification sub-team, the feasibility analysis sub-team, the plan and define project details sub-team, and the build and test experimental sample sub-team from the formulation development team. This group of team members consists of 15 members. After using a product development program, 15 people on the formulation development team evaluated their satisfaction after using the tool. The topics that are used for satisfaction assessment after using the program are divided into two parts: The topics that are used for satisfaction assessment after using the program are divided into two parts: At the manager level, the implementation of a database system assists in the management of data in product development; the implementation of a database system aids in the standardization of product development data; and the implementation of a database system assists in the collection of product development knowledge for use in the development of new products. At the staff level, the implementation of a database system makes obtaining information for product development easier; the implementation of a database system assists in reducing data redundancy in the product development process; the implementation of a database system aids in the standardization of product development data; the implementation of a database system assists the information in work more organized; and the implementation of a database system assists in the collection of pertinent data for use in the development of new products. Table 2 presents a form for evaluating satisfaction after using the product development program. All of the samples in this survey are population of product development team. The observation duration is 7 days because it represents the weekly cycle of work in the product development process, and the questionnaire is conducted on a Google form that can be accessed online.

Table 2 The form for evaluating satisfaction after using the product development program.

Question	Satisfaction level				
	1	2	3	4	5
For manager level					
1.) The implementation of a database system to assists in the management of data in product development.					
2.) The implementation of a database system aids in the standardization of product development data.					
3.) The implementation of a database system to assists in the collection of product development knowledge for use in the development of new products.					
For staff level					
1.) The implementation of a database system makes obtaining information for product development easier.					
2.) The implementation of a database system assists in reducing data redundancy in the product development process.					
3.) The implementation of a database system aids in the standardization of product development data.					
4.) The implementation of a database system assists the information in work more organized.					
5.) The implementation of a database system to assists in the collection of pertinent data for use in the development of new products.					

2.4.2 Evaluate working time.

The performance of the projects following the implementation of the product development program was measured in terms of time spent working during the product development process. The working time after utilizing a program includes the time necessary to complete the sub-processes of the formulation development process, which include customer needs identification, feasibility analysis, and the building and testing of experimental samples. In the second part, the working time from traditional and new procedures for managing data in the formulation development process is also stored. This work measured the working time of input and search information for hardness testing from traditional and new procedures because it has several workflow iterations. Because the data management technique of the quality testing process is comparable to other methods, the hardness test procedure is utilized as a sample. Furthermore, because recording and searching is the major method for managing product development data, the recording and retrieval procedure was utilized as an example for collecting the working time. The working time from the first section was compared before and after executing the product development program to assess the impact of the program's performance on the project's working time. Furthermore, the second part of working time uses the time study approach to approximate observation times to improve data accuracy. The working time was then compared between the traditional and new procedures.

3. Results

3.1 Employee satisfaction results

The questionnaire method was a method for data collection in this research and was divided into two parts. First, collect personal information from the population by using a checklist questionnaire. Second, collect employee satisfaction data after utilizing a program for visualizing work status and a product development program of the formulation development process by using questions and a 5-level scale.

Level 1 was denoted as very unsatisfied.
Level 2 was denoted as unsatisfied.
Level 3 was denoted as neutral.
Level 4 was denoted as satisfied.
Level 5 was denoted as very satisfied.

After gathering the data, the researcher converted the score by using interval criteria.

$$Interval = \frac{Highest\ values - Lowest\ values}{Classes} \quad (1)$$

As a result, interval criteria in data analysis consist of

The range of values from 1.00 to 1.80 was denoted as very unsatisfied.

The range of values from 1.81 to 2.60 was denoted as unsatisfied.

The range of values from 2.61 to 3.40 was denoted as neutral.

The range of values from 3.41 to 4.20 was denoted as satisfied.

The range of values from 4.21 to 5.00 was denoted as very satisfied.

This research used two types of statistics to analyze the data: those consisting of descriptive statistics and quantitative statistics. In Questionnaire 1, personal information such as the number of users from each position was analyzed using the percentage value. The researcher analyzed trends of information and the distribution of the Questionnaire 2 described by mean and standard deviation.

3.1.1 Employee satisfaction results from the program for visualizing work status.

According to table 3, the number of people who use the program to visualize their work status is divided into managers, accounting for 18%, and staff, accounting for 82% of the total population. The overall level of employee satisfaction from managers when using the program is very satisfied, with a mean of 4.33 and a standard deviation (SD) of 0.31. For each questionnaire, the most satisfied is that it contributes to easier project management at a very satisfied level, with a mean of 4.61. The lowest satisfaction is that it helps in effective people management at a satisfied level, with a mean of 4.00, since some users do not comprehend how to use the program or want to try out more of it. At the staff level, the overall level of employee satisfaction is satisfied, with a mean of 4.09 and a standard deviation (SD) of 0.67. In the questionnaire, the most satisfied is that it is useful for keeping track of work activity information at a very satisfied level, with a mean of 4.29. The lowest satisfaction is that it aids in the control of work time, with a mean of 3.86, since restrictions on language in the program and program security limitations make it difficult to use. As a result of employee satisfaction, managers are very satisfied, and staff are satisfied with the program. It can enhance the efficiency of managing projects within the new model development team. Table 3 shows the result of employee satisfaction from a program for visualizing work status.

Table 3 The result of employee satisfaction from the program for visualizing work status.

Population characteristics	Percentage	Satisfaction level	Mean	SD
Manager	18	Very satisfied	4.33	0.31
Staff	82	Satisfied	4.09	0.67

3.1.2 Employee satisfaction results from formulation development program.

According to table 4, the formulation development program is used by managers, accounting for 27%, and staff accounting for 73% of the total population. The overall level of satisfaction from the manager is very satisfied, with a mean of 4.25 and a standard deviation (SD) of 0.31. At the highest level of manager satisfaction, a program helps in the accumulation of product development information for use in the creation of new products, and the value is very satisfied

(mean = 4.50). At the lowest level of manager satisfaction, a program aids in data management during new formulation development, and the value is satisfied (mean = 4.00) because it needs to improve the appearance of the system and do extra tests for actual work with the organization.

At the same time, the satisfaction overview from staff is very satisfied, with a mean of 4.24 and a standard deviation (SD) of 0.64. At the highest level of staff satisfaction, a program assists in obtaining the data for developing formulations of disc brake pad products more conveniently at a very satisfied level, with a mean of 4.45. At the lowest level of staff satisfaction, a program assists with the normalization of formulation design data and aids in the administration of work information at a satisfied level, with a mean of 4.09, because the interface should be improved to make it more attractive and effective, the coverage of information should be expanded to include more tasks, and the data entry technique should be improved to simplify things. As a result of employee satisfaction, managers and staff are very satisfied with the program. It can enhance the convenience of data collection when developing formulations of disc brake pad products. Table 4 shows the result of employee satisfaction from the product development program.

Table 4 The result of employee satisfaction from the product development program.

Population characteristics	Percentage	Satisfaction level	Mean	SD
Manager	27	Very satisfied	4.25	0.31
Staff	73	Very satisfied	4.24	0.64

3.2 Working time results.

3.2.1 Working time needed to finish a sub-process of the formulation development process.

Table 5 shows that the working time to complete the customer need procedure before and after applying the product development program is 43 and 41 days, a 2-day difference. The working time to complete the feasibility study procedure before and after applying is 20 and 13.7 days, a 6.3-day difference. Furthermore, the working time to complete the building and testing of experimental samples procedure before and after implementation is 201 and 194.2 days, a 6.8-day difference. A product development program helps save working time in formulation development sub-processes by 15.1 days, or 5.72%.

Table 5 Working time to finish sub-processes before and after implementing the product development program.

Process	Before (day)	After (day)	Difference time (day)
Customer's need identification	43	41	2
Feasibility analysis	20	13.7	6.3
Building and testing of experimental samples	201	194.2	6.8
Total	264	248.9	15.1
Difference (%)			5.72

3.2.2 Working time from management data procedure in the formulation development process.

According to table 6, when comparing the working times of the traditional and new methods, they utilized a working time of 0.53 and 0.40s for the input data procedure, a difference of 0.13s or 24.53%. They utilized a working time of 0.40 and 0.16s, respectively, for the searching data procedure, a difference of 0.24s or 60%.

Table 6 Working time of traditional and new data management processes.

Process	Before (s)	After (s)	Difference time (s)	Difference time (%)
Input for hardness test data	0.53	0.40	0.13	24.53
Search for hardness test data	0.40	0.16	0.24	60.00

4. Conclusion and suggestions

After implementing the program for visualizing the status of work using the Proof Hub program, it was found that for managers, the program can improve project management efficiency at a very satisfactory level, with a mean of 4.33. However, for staff, the program can improve project management efficiency at a satisfactory level, with a mean of 4.09. This tool supports project management efficiency by tracking and displaying project progress from all projects, keeping team members notified at all times, and allowing them to handle their own activities in a simple and timely manner. It also helps manage events that have been found to be delayed easily and faster for managers. It displays both immediate and long-term goals and gives a full explanation of what has to be done in each action, assisting workers in preparing for real-time. As a result, it aids in improving collaboration activity administration and effective project management, as well as assisting the organization in enabling more systematic operation in order that improve the efficiency of project management inside the team.

In addition, managers and staff were very satisfied after using a product development program in the formulation development procedures, and the program improved the data collection processes, with a mean of 4.25 and 4.24, respectively. Furthermore, it can save 5.72% of the working time of a sub-step in the formulation development process. It can reduce the working time spent on data organizational processes such as input and search for hardness test data by 24.53% and 60%, respectively. This tool aids the data gathering process by storing and managing data using the same standardized format. It assists in collecting data on a consistent basis and makes it easy to save, search, and retrieve for analysis during the formulation development process. It is stored on a centralized computer server and each component is allocated different access permissions, so it helps appropriate users directly access it all the time. It has space storage that switches from physical to centralized server storage and is grouped into categories, minimizing physical form storage space and making it

readily searchable. The transition from traditional methods to programs can make people's jobs easier and eliminate the loss of motion associated with previous methods. As a result, this application has the potential to increase data collection in formulation development procedures.

In future work, in order to increase the program's effectiveness and the organization's project management performance, the corporation should widen the range of the process and the employees who utilize it. Furthermore, users should study all the features in the software for an overall comprehension of the application as well as for ease and flexibility. Furthermore, the corporation should build the product development program to cover the scope of data in all working processes; create the technique for data entry and searching; develop the design of the user interface; and keep developing this program for more efficient usage.

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