DEVELOPMENT OF APPLICATION FOR MANAGING JOBS AND DOCUMENTATION RELATING TO OCCUPATIONAL HEALTH AND SAFETY IN A TOYS COMPANY

Hery Hamdi Azwir[*)], Gusti Ayu Dewi Puspa Kartikasari,

Industrial Engineering Study Program, Faculty of Engineering, President University
Jl. Ki Hajar Dewantara, Jababeka, Cikarang, Bekasi - Indonesia 17550

(Received: May 22, 2019/ Accepted: May 6, 2020)

Abstract

PT. X has two procedures to control and monitor every work that is carried out inside the company area. One of them is Work Permit or known as Permit to Work (PTW). As identified during its direct observation in a quantitative approach by flow process chart and document flow chart, there are several problems in the system. The existing system has also been identified as running ineffectively. Management of PT X approved application development for the system as the problem solution. By following the guidance of SDLC phases, two customized applications were developed using visual basic for application. At last, a further observation was carried out following their implementation to the system. The final result of this research shows that the applications are successfully improving the system.

Keywords: *DFD; health; occupational; safety; SDLC; VBA*

1. Introduction

Occupational injuries and accidents could be prevented and eliminated by implementing measures and methods that already exist. Many industrial organizations have extensively implemented a comprehensive system of occupational safety and health (OSH) management and contribute by consistently reduced accident rates. (Reese, 2017). The economic costs of injuries and deaths are extraordinary and imply individuals, enterprises, and nations and indeed the entire world. Considering compensation, lost working time, interruption of production, training and retraining, medical expenses, and so on, estimates of these losses are routinely put at roughly 4 percent of global GNP every year, and possibly much more. (Alli, 2008).

In Ontario, Canada, around $ 2.5 billion is spent annually on workplace accidents in the health sector. The health care sector has been ranked second highest for the rate of lost-time injuries among 16 Ontario sectors since 2009 with female health workers ranking highest among all jobs for time-loss claims. (Almost et al, 2018). A study seeks to examine the relationship and impact of occupational health and safety on employees' organizational commitment in Ghana's mining industry, which explores occupational health and safety and the different dimensions of organizational commitment. (Amponsah-Tawiah, 2016). There is also a study for examining occupational hazard exposures and health risks in the wooden toy processing industry in Southern Thailand. (Thepaksorn, 2019).

Mohammadfam, et al, develop a method for assessing the performance of the Occupational Health and Safety System based on key performance indicators in Iran. (Mohammadfam, 2017). The characteristics of work in the 21st century have created new problems related to worker health, such as new types of work-related disorders, non-communicable diseases, and inequality in the availability of occupational health services that require a culture of prevention at the national level. This brings ideas to Yangho about how to change safety cultures in both theory and practice at the level of the workplace; and finding the role of prevention culture at the national level. (Yangho, 2016)

PT. X is one of the famous child toy manufacturers in Indonesia, it has more than four thousand employees and two plants in Indonesia. Accordance with it, the company required to have good safety management to ensure the safety of each worker is assured. To fulfill the requirement, the company implements and keeps improving the existing system and its procedure, one of them is a procedure that is used to control and monitor any work inside the company area. To data tracking and monitor both routine and non-routine activities, the company has Risk Assessment and Permit to Work.

[*)] Corresponding Authors.
E-mail: hery.azwir@president.ac.id

In this permit to work procedure, there are four types of documents that must be filled when proposing a work according to its type. First is Permit to Work (PTW) form that required to propose all type works, the second is hot work permit form to propose works with a high risk of hazards such as work with the usage of heat or fire, the third is work at height form for work that works at height more than 1.2 m and the last is Job Safety and Environmental Analysis (JSEA) form that used to identify any risk that may come from the work environment.

The registration process of those forms contains repetitive action that occurred every time users propose a work permit. Following the number of documents that should be processed, it multiplied and generates problems in the system. From direct observation, several problems are identified in the system. To eliminate or reduce the problems, this paper proposes an idea to develop an application that can do registration automatically in any computer that connected to the company's server and functioned to synchronize all four documents required.

2. Methods

According to (Kendall, 2019), developing a good quality an information system or an application requires these stages: information gathering, user requirements, analysis, design, development, testing, and implementation.

2.1 Information Gathering and User Requirements

For gathering information and user requirements, document flowchart and process flowchart will be used. A process flowchart shows the sequence of a continuance of process for a product or any component of it. This chart is created by recording the process using symbols. The symbols are available for operations, inspection, storage, delay, and transportation. (S.B. Patil, 2008). There are many variations of process charts where each of them is designed for a specific level or stage of analysis (Harikarthik et al, 2011).

Figure 1 shown each symbol for each process type inflow process chart, the process in the system will be recorded by using symbols connected to another in sequence. Information about the process is described using these symbols and flow charts.

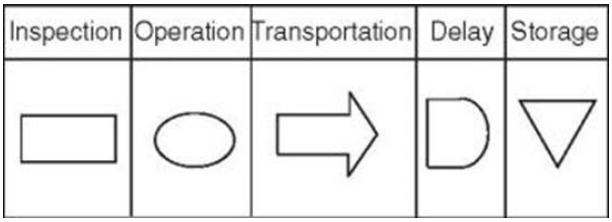

Figure 1. Flow Process Chart Symbols (Source: http://www.indmedica.com/journals.php?journalid=6&issueid=104&articleid=1437&action=article)

2.2 Analysis

System Development Life Cycle (SDLC) is applied to defines the process and functions that every system developer should fulfill without consider the tools they use. Data flow diagram (DFD) visualized the relationship between various elements in the program or system. DFD is a useful method in the visualization of a system in high-level detail by showing the way input data processed to output results through sequences of process. DFD used by the system designer and others when initial analysis stages to envision the current system or another that may be essential to meet the new necessity. Systems analysts select working with DFD, mostly when they need a rich understanding of the boundary among present systems and suggested systems. DFD consist of four major components: entities, process, data stores, and flow of data. (Azwir, 2017)

2.3 Design

Design is related with the user interface and database. The user interface is a correlation between system or device with the user which enables the two to interact with each other. The connection itself can be in a physical or logical form. In the computer, the user interface generally consists of a display device, mouse, and keyboard. Furthermore, there are 2 categories of the user interface in the display device which are command-line interface (CLI) that only consist of text and graphical user interface (GUI) that consist of images. (Linux Information Project, 2005),

2.4 Development, Testing, and Implementation

The system will be developed using Visual Basic for Application (VBA) which is a collaboration between Microsoft's event-driven programming language Visual Basic with Microsoft office applications. Those applications are Microsoft Excel, Microsoft Word, Microsoft PowerPoint, and others. By executing the Visual Basic IDE in Microsoft Office application, the developer can create a modified solution and program to boost the ability of the application.

Within all VBA, the most common among users is Microsoft Excel VBA. The reason is the user does not have to purchase a copy of Microsoft Visual Basic software to learn the basics of Visual Basic programming. There are two ways to start VBA programming in Microsoft Excel, clicking the created command button to access the VBA editor for that button and the other is accessing the VBA through tools menu-macro-visual basic editor (Alexander, 2019)

Figure 2 is the example of VBA commands whereby clicking the command button, the commands that running is filling cell A1 until A10 with statement 'Visual Basic' and fill cell C11 with value in cell A11 added by value in cell B11. (Liew, 2009)

```
Private Sub CommandButton1_Click ()

        Range ("A1:A10).Value="Visual Basic "

        Range ("C11").Value=Range ("A11").Value +Range ("B11").Value

End Sub
```

Figure 2. Examples of VBA Commands (Source: Liew, 2009)

This is the example of VBA commands whereby clicking the command button, the commands that running is filling cell A1 until A10 with statement 'Visual Basic' and fill cell C11 with value in cell A11 added by value in cell B11. (Liew, 2009)

3. Results and Discussion

3.1 Information Gathering

3.1.1 Document Flow Chart of Existing System

In figure 3, it can be seen the document flow in the system. This diagram also explains the process inside the system for every component. The components that contribute to the system are user, PTW administrator, and EHS engineer. The user is PT X staff from any department who requesting or lead a non-routine work inside the company area, the administrator is the secretary of the EHS department, and EHS engineer is engineer under EHS department.

Figure 3 shows the flow of process and documents in each component which are user, PTW administrator, and EHS engineer. The first process is in the user, they fill hard copy PTW and JSEA forms and then send them to PTW administrator to be registered and obtain a registration number for each form. After that, the forms will be sent to EHS engineer to get a hazard review for the non-routine requested in those forms. After review, the document will be taken by the user and used as a reference for work at height and hot work e-form registration. Then, after the e-forms filled, the second registration is started by sending them to the PTW administrator. In PTW administrator, the forms will get their number related to PTW form number and sent back to the user. After received by the user, the e-form is printed and bundled with two previous forms and it finished the registration process.

3.1.2 Flow Process Chart of Existing System

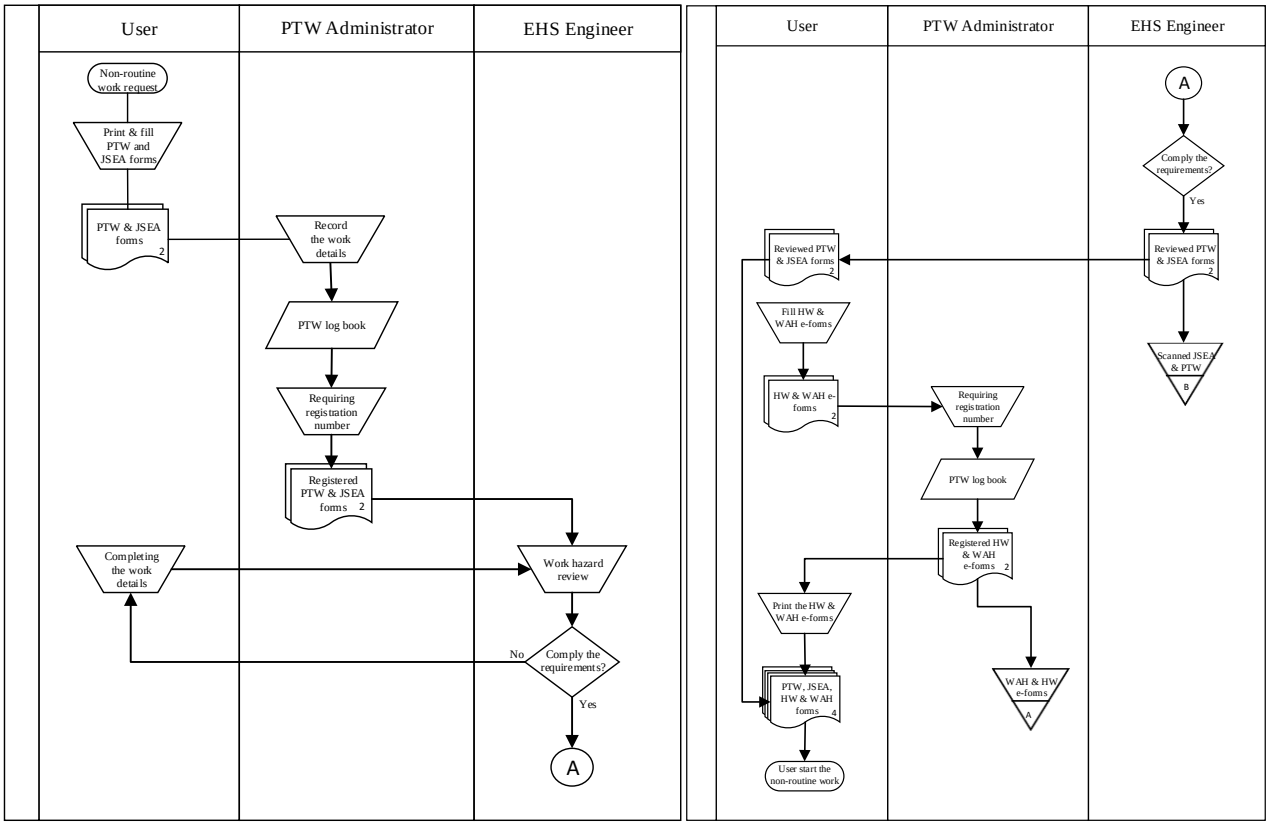

Figure 3. Document Flow Chart of Existing System

No	Process Description	Symbols					Time Measured (s)
		Operation	Inspection	Transport	Delay	Storage	
1	Access the forms file	○	□	⇨	D	▽	21
2	Print the form	○	□	⇨	D	▽	84
3	Write job details	○	□	⇨	D	▽	182
4	Transport the forms to EHS dept	○	□	⇨	D	▽	75
5	Wait for administrator to be available	○	□	⇨	D	▽	98
6	Register the works on the log	○	□	⇨	D	▽	57
7	Requiring new register number	○	□	⇨	D	▽	18
8	Write the register number on the forms	○	□	⇨	D	▽	21
9	Move the forms to EHS Engineer	○	□	⇨	D	▽	10
10	Wait for EHS Engineer to be available	○	□	⇨	D	▽	86
11	Hazard review by EHS Engineer	○	□	⇨	D	▽	151
12	The forms stored in the PTW map	○	□	⇨	D	▽	77
13	Wait for users to get the form back	○	□	⇨	D	▽	76
14	The forms searched by user	○	□	⇨	D	▽	28
15	The forms back to users table	○	□	⇨	D	▽	61
16	Access Electronic forms	○	□	⇨	D	▽	25
17	Typing to fill the electronic forms	○	□	⇨	D	▽	293
18	Send the doc through the email to EHS dept	○	□	⇨	D	▽	45
19	Requiring new serial number for e-form	○	□	⇨	D	▽	63
20	Typing the serial number on the document	○	□	⇨	D	▽	107
21	Store the forms in the server	○	□	⇨	D	▽	26
22	Send the forms to users through email	○	□	⇨	D	▽	50
23	Print the forms	○	□	⇨	D	▽	117
TOTAL TIME (s)							1771

Figure 4. Flow Process Chart of Existing System

After system visualization, a time measurement is done and presented using a flow process chart. In this chart, each process is categorized as operation, inspection, transportation, delay, and storage. From figure 4 it can be seen that there is 23 process that should be done to complete the overall process. The total processing time of the system is 1771 seconds or 29 minutes and 31 seconds with 1 inspection, 11 operations, 5 transportation, 4 delays, and 2 storage processing.

3.1.3 Problem Identification

After the document flow chart and flow process chart are created from data gathered during direct observation, some analyzations are carried out to identify the problem. Those analyzations are from the data in both diagram and chart and the other one is problems that identified from direct observation. To identify the problems that exist in the system from data in two diagrams above, an analysis is carried out. Table 1 is the combined summary from them.

Table 1. Processing Time for Process Type in Each Components

Component / Process Type	Operation (s)	Inspection (s)	Transport (s)	Delay (s)	Storage (s)	Total (s)
User	722	0	181	104	0	1007
Administrator	266	0	60	98	0	424
EHS Engineer	0	151	0	86	77	314

Table 2. Problem Solution

No	Problems	Action	Solution
1	Complains for complex process and spending more time to monitor the process		
	High number of documents movement in the system	Yes	Enable the user to do self-registration by developing application. This will eliminate the document movement to administrator.
	Separated registration method for different forms	Yes	Enable all four documents registration at once in the application.
2	High possibility of long delays		
	Possibility that document receiver is unavailable	No	-
	Unnoticed forms	No	-
	Sudden request	Yes	Enable user to do registration at any time in any computer connected to company's server
	Technical issue (computer or broken printer)	No	-
3	Missing Documents		
	Lack of coordination in documents transition	No	-
	Improper documents placement / arrangement	Yes	Reduce the possibility of forms storage by unable user to directly continue the process to one of EHS engineers.

Table 1 shows the time required to do each process type in each component. The highlighted number is the total time for delay in each component of the system. If viewed from the flow chart, the source of delay in user waits for users to get the form back and the forms searched by the user, for the administrator is waiting for the administrator to be available, and for EHS engineer is waiting for an engineer to be available. All components inside the system have their delay, this identifies the system run ineffectively.

3.1.4 Proposed Solution

There are two problem solutions that capable to be implemented in PT X. The first one trains one of EHS team members to be able to cover the job of the administrator, and the other is developing an application to be implemented inside the system.

After discussing with the EHS manager, the result is shown in table 2 that presents the recommended solution based on the existing problem, the option that chosen is developing an application for the system. It is because it does not give another workload to any EHS team member to handle administrator's job when she/he away, enable the system to run with minimum human force to minimize human uncertainty and error and enable the process to run anywhere and anytime from any computer connected to the server even after the office hour is over.

The application is mainly purposed to fully handling the registration process, the processes that will be eliminated mostly inside the administrator's role. These are the proposed application requirements:

a. The application will be in charge to do registration automatically for all the four documents. It is included to record the work details in the PTW logbook for yearly records and obtain a registration number for each document.
b. It will enable the user to specify which documents they require for the works.
c. It generates a new registration number for each registration process automatically, but it is based on the required documents that specified by the user
d. After the registration, it is open and fills all of the four documents automatically with work details also based on the required documents specified by the user.

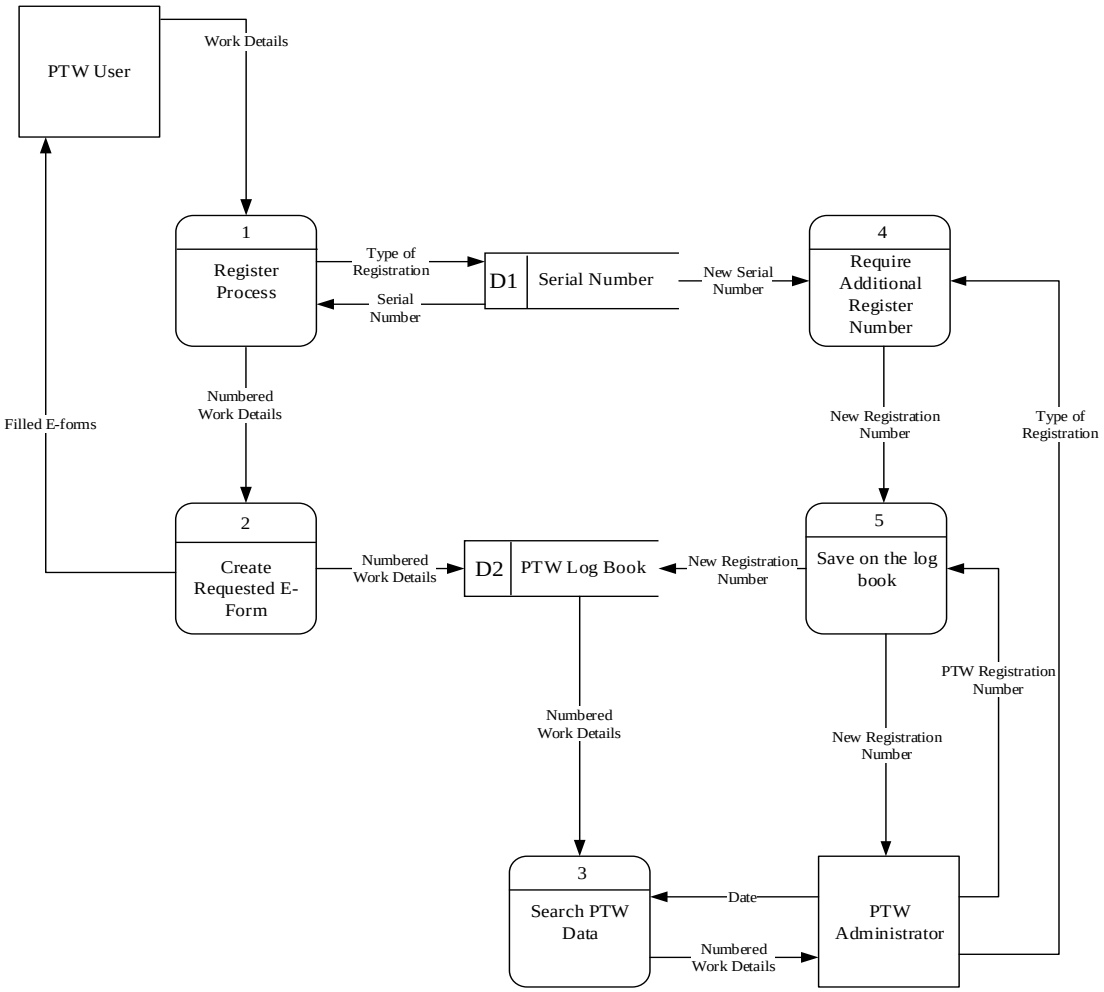

Figure 5. Level 1 DFD

e. Have data search ability that enables access to data in the PTW logbook for PTW audit material. The searches itself are based on the work date, submission date, and the PTW registration number categories.
f. Have the ability to generate and register a new registration number over existing data in the PTW log book.

The application does not require to handle all system process because PT X management has consideration for maintaining the hazard review to be done manually. The reason is the review should be done by considering a wide variety of work conditions. Various factors might affect the work hazard and its risk. This complex process is better left in human ability that can combine and identify the factors and give preventions for them.

3.2 Analysis

To describing the flow of the data in the application, a data flow diagram is required. It will be quite helpful for those involved in the system whether it is user, developer, or administrator to understand the logic of the application in more detail. This figure is the breakdown data flow inside the PTW Registration System. The system itself divided into 5 main processes and each of the data flow in context level is directed to each process based on what process it is required. Those data will be processed become different information that sends toward another processor as a search criterion just like in process 5. In that process PTW registration number is the search criteria, it means the new registration number will be saved based on the row where the criteria founded.

3.3 Design

The user interface is the way the application interacts with its user. All of the things shown in the computer monitor, all that can be read and changed by using input hardware is the user interface. As in this system, it consists of user forms, message box, the application display, and also the databases.

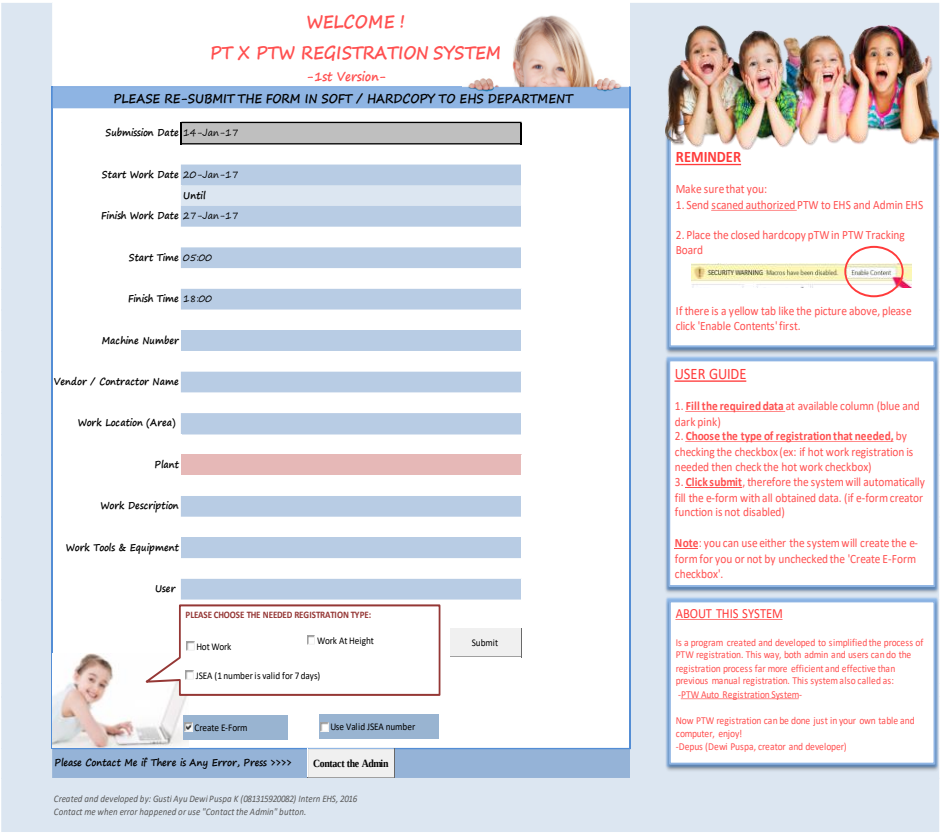

Figure 6. PTW Register Design

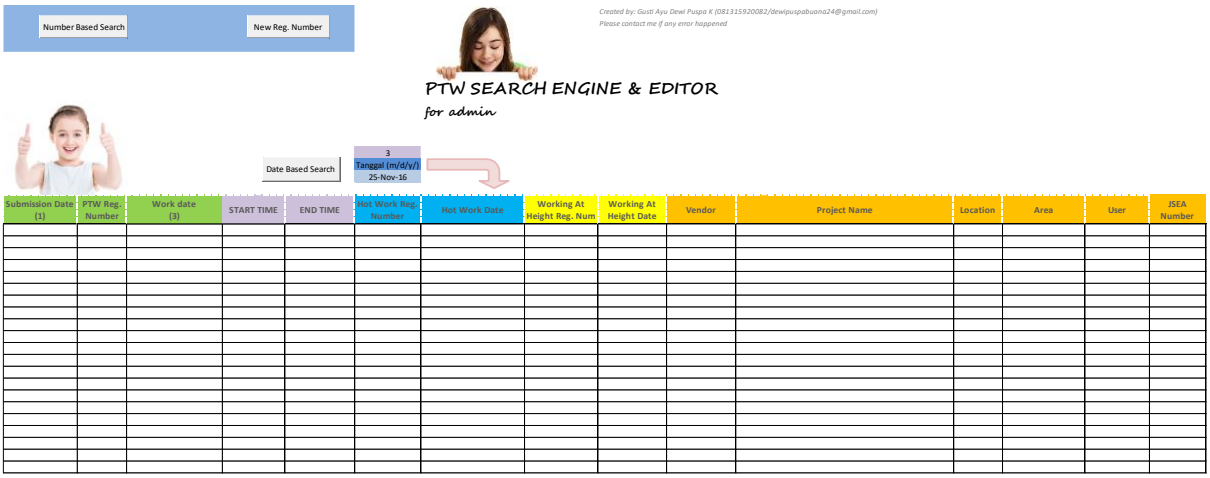

Figure 7. PTW Access Design

Figure 6 is the display of PTW Register's main view. As shown in the figure the gray cell is the submission date that automatically filled by the system, blue and red cell is the required entry and there are checkboxes inside a red-lined box which is the indicator of each registration type that requested by a user. On the right sides of the entries are a reminder, a simple user guide, and a short description of the system.

Figure 7 can be seen as the design of PTW Access where displayed 3 buttons, which the upper left button is number-based search buttons, at the upper middle is new reg. number button and the one in the center is a date-based search. For the date-based search process, the results are not shown in a user form, but the tables shown in the lower part of this figure. The columns itself can be adjusted along the amount that data identified during the process.

3.4 Development, Testing, and Implementation

3.4.1 Application coding

All process specifications from the analysis phase are transformed into application coding by using Microsoft Excel VBA Macro. The applications itself developed to use a lot of user forms and messages boxes as there is a lot of possible routes

taken by both user and admin.

3.4.2 Document flow chart of Improved System

After the implementation, the registration system itself changed and the document flow will be different from the previous system. To know the change, here is the document flow chart.

From the diagram in figure 8, it can be indicated that the system only has two components with the implementation of the registration application in it. The process inside the improved system is the user register the work through the application, adding specific information after obtaining the auto-generated e-forms, print the document and send it to EHS engineer. In EHS engineer, the forms will be reviewed for work hazards. After that, the form can be immediately taken by the user and it finishes the process.

3.4.3 Flow Process Chart of Improved System

If the flow of documents is different from the previous system, the change may also happen in the total processing time. To measure the improved system, a time study is done one more time. The result is presented in the flow process figure 9.

From figure 9 it can be seen the improved flow process chart has 11 processes with 1 inspection, 6 operations, 3 transport process, 1 delay, and 1 storage process. The delay that remained is 'wait for EHS Engineer to be available because consideration auto reviewing may cause misdirection in the safety review. It also can be seen the total processing time is 986 seconds or 16 minutes and 26 seconds.

3.5 System Comparison

After the observation was done, the result is compared between the previous system with the improved system. These comparisons will indicate the role of the two applications in PTW registration system improvement, the effect and identify the success of the improvement itself. In the improved system, the role of administrator and difference registration method for certain forms are eliminated from the system. This solution indirectly reduces the factors that may cause a delay. The role of administrator is eliminated by replacing manual registration through administrator become auto registration through an application.

4. Conclusion

Several conclusions can be drawn after completing this research. The conclusions are explained as follows: (1) In the previous system, several problems exist. Those problems are a complicated process, long process delays, and missing forms. (2) Through both system comparisons from the flow process chart and document flow chart

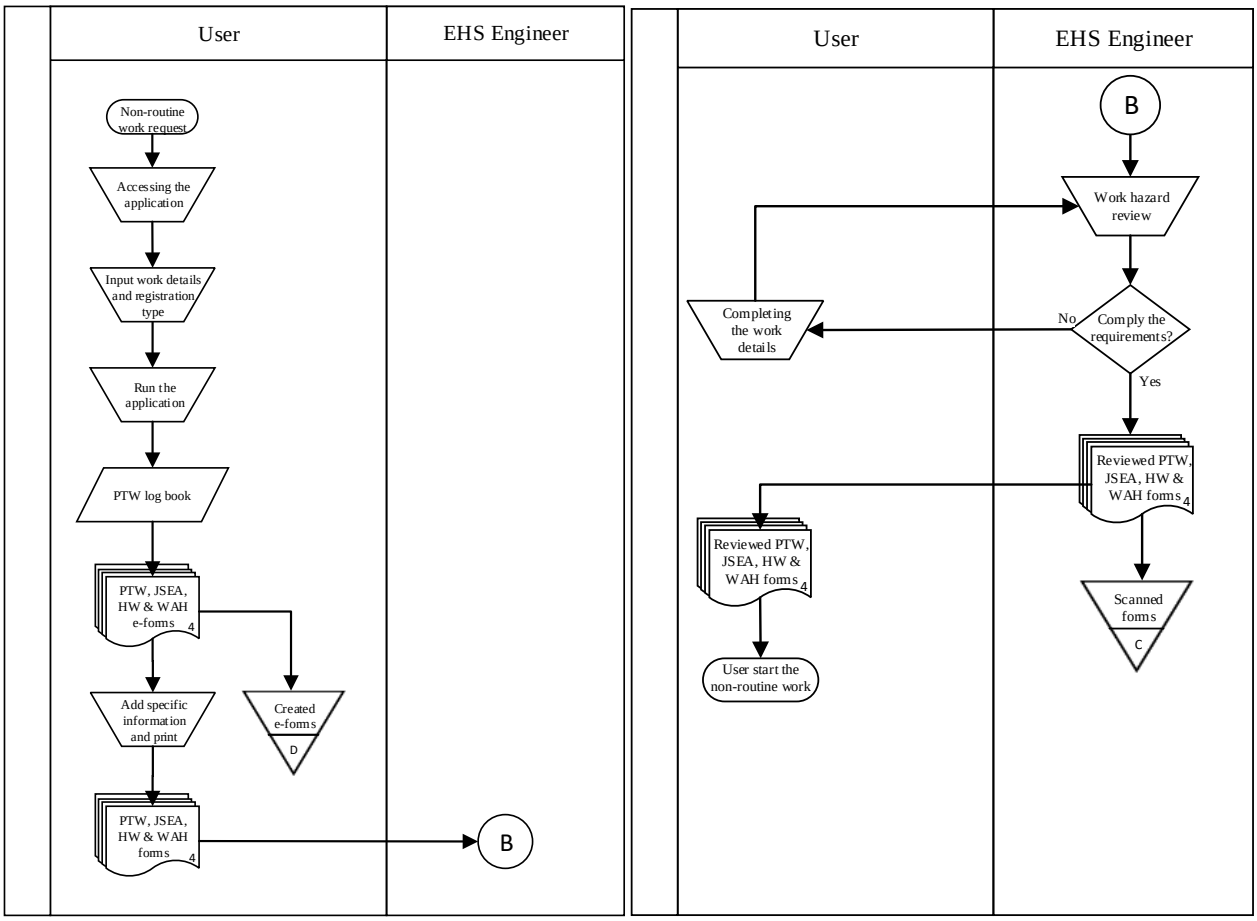

Figure 8. Document Flow Chart of Improved System

No	Process Description	Symbols					Time Measured (s)
		Operation	Inspection	Transport	Delay	Storage	
1	Access PTW Register (software)	○	□	⇨	D	▽	25
2	Type the work description	○	□	⇨	D	▽	56
3	Choose the type of registration	○	□	⇨	D	▽	8
4	Run the software (registering PTW and forms)	○	□	⇨	D	▽	13
5	Adding specific information to the forms	○	□	⇨	D	▽	109
6	Save the forms to the server	○	□	⇨	D	▽	199
7	Print all of the forms	○	□	⇨	D	▽	161
8	Move the forms to EHS Engineer	○	□	⇨	D	▽	72
9	Wait for EHS Engineer to be available	○	□	⇨	D	▽	75
10	Hazard review by EHS Engineer	○	□	⇨	D	▽	203
11	The forms taken by users	○	□	⇨	D	▽	65
TOTAL TIME (s)							986

Figure 9. Flow Process Chart of Improved System

and also data flow diagram can be seen that the application is reduced problems that exist inside the previous system. (3) Improvement is accomplished by system management using the implementation of two customized applications in the PTW registration system.

5. Acknowledgments

Thank PT Mattel, a well-known and world-wide toy company in Cikarang for allowing us to conduct this research.

6. References

Alexander, Michael, Kusleika, Dick. (2019). *Excel® 2019 Power Programming with VBA*. John Wiley and Sons.

Alli, Benjamin O. (2008). *Fundamental principles of occupational health and safety*. International Labour Office.

Almost, Joan M. et al. (2018). *A study of leading indicators for occupational health and safety management systems in healthcare*. BMC Health Services Research 18:296.

Amponsah-Tawiah, Kwesi. Mensah, Justice. (2016). *Occupational Health and Safety and Organizational Commitment: Evidence from the Ghanaian Mining Industri*. Safety and Health at Work 7 225-230.

Azwir, Hery H., Patriani, Oktavia. (2017) *Perbaikan Pengelolaan Pergudangan Melalui Penerapan Sistem Informasi Pergudangan di CV. ABB*. Jurnal Optimasi Sistem Industri (JOSI), Vo. 16. No. 1.

Harikarthik, S., G., Mohanram, P., V., and Rajenthirakumar, D. (2011). *Process Cycle Efficiency Improvement through Lean: A Case Study*. PSG College of Technology

Kendall, Julie, E., and Kendall, Kenneth E., (2019). *Systems Analysis and Design. 10th edition*. New Jersey: Pearson Prentice Hall

Liew, V. K. (2009). *Excel VBA made easy: a concise guide for beginners*. Lexington, KY: Liew Voon Kiong.

Mohammadfam, Iraj. et al. (2017). *Evaluation of the Quality of Occupational Health and Safety Management Systems Based on Key Performance Indicators in Certified Organization*. Safety and Health at Work 8 156-161.

Patil, S.B. (2008). *Industrial Engineering and Management* (1st ed.). India: Technical Publications Pune.

Reese, Charles D. (2017). *Occupational Safety and Health: Fundamental Principles and Philosophies*. CRC Press.

Thepaksorn, Phayong. et al. (2019). *Occupational hazard exposures and health risks at the wooden toy industry in Southern Thailand*. Human and Ecological Risk Assessment: An International Journal. https://doi.org/10.1080/10807039.2019.1656053

The Linux Information Project. (2005). *User Interface Definition*. Retrieved January 23, 2017, from http://www.linfo.org/user_interface.html

Yangho, Kim et.al. (2016). *Creating a Culture of Prevention in Occupational Safety and Health Practice*. Safe and Health at Work 7 (2016) 89-96