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MechEng
Mechanical Engineering

APPLYING PDCA CYCLE IN EFFICIENCY IMPROVEMENT FOR CONTROL OF SUSPICIOUS PARTS

BACHELOR THESIS



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Ho Chi Minh, 08.02.2022

ABSTRACT

This dissertation aims to improve the efficiency of controlling suspicious parts by using a digital tool in a bearing manufacturing company and direct an assessment concentrating on re-examining issues to continuous development. The tool's categories and components were elicited by analyzing paperwork for everyday use. A pilot study was completed to approve the assessment device. Usability was tested by approximately 400 operators and 5 Quality Segment (Q-segment) using the tool; interviews and field observations were also conducted.

This dissertation aims to show the advantages of using a web-based and user-centered application for the control of potentially non-conforming products (suspect parts) compared to the old traditional process. There is transparency regarding the handling of suspect parts and ensuring that suspect parts are not delivered to internal and external customers. Able to use the system as a quick response quality control to eliminate failures timely.

From the results, it is easy to figure that both operator and Q-Segment did not have much problem using the system, reduced not only the workload but also control the suspect parts more efficiency, but felt unsatisfied with the analyzing since data form exported was different from the excel file that Q-Segment used. Results imply that the platform should be improved in facilitating managing data and analyzing. The thesis proposes some augmentations to tackle issues in the transition process and minimize user dissatisfaction by applying the PDCA cycle.

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ABBREVIATIONS

CoSP	...	<u>C</u> ontrol <u>O</u> f <u>S</u> suspicious <u>P</u> art
WIP	...	<u>W</u> ork <u>I</u> n <u>P</u> rocess
DAI	...	<u>D</u> igital <u>A</u> dooption <u>I</u> ndex
PDCA	...	<u>P</u> lan <u>D</u> o <u>C</u> heck <u>A</u> ct
IoT	...	<u>I</u> nternet <u>o</u> f <u>T</u> hings
RPA	...	<u>R</u> obotic <u>P</u> rocess <u>A</u> utomation
WI	...	<u>W</u> ork <u>I</u> nstruction

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I. INTRODUCTION

In today's world, digital is one of the most problematic aspects of human existence, not only because it is a trend but also because of the great benefits it provides. In the industrial business, digital has long been seen as the ultimate aim of progress. It not only has a direct impact on quality, manufacturing time, and decision making, but it also impacts the entire organization's system and business boundaries.

In the past, when people stored their information on paper, it was a massive disadvantage since the form would be rusted through times, and it was tough to preserve. Traditional industrial techniques are always viewed as inferior in productivity and the economy due to a lack of digital technologies. So, why has digital evolved into a new development in recent decades, while many businesses continue to use old traditional procedures?

First, we must evaluate that there are still numerous advantages to using the old method. As we offer people the right to decide on their own, they have the right to make decisions that they believe are in their best interests. It could be correct or incorrect. However, with the assistance of machines and digital tools, judgments may now be made more efficiently and accurately, owing to the exact computation of a superior computer system. We can observe in the previous system how an engineer works hard to attain success and efficiency. Nevertheless, by combining current techniques with humanity's unlimited intelligence, labor can be significantly reduced. People will have more time for creativity rather than focus on manual tasks all day. This will bring about a new development in the working environment, encouraging people to be more entrepreneurial, resulting in limitless achievements in the company and the reform of modern industry in general. Digital technology is gradually breaking down the obstacles to manufacturing output due to breakthroughs in numerous sectors.

The industrial revolution of the last few decades has been elevated to a new level thanks to the Internet of Things (IoT), real-time data access, and the advent of physical systems cyber management. The revolution allows for a more integrated and comprehensive approach to the manufacturing process. The system facilitates greater collaboration and access between departments as well as between partners, suppliers, goods, and individuals. The ability to better oversee and understand every edge of the operations

system, as well as the ability to exploit real-time data, empowers the business owner to increase productivity, improve procedures, and drive growth.

Approximately two thousand organizations across twenty-six countries are targeted in the survey "Industry 4.0: Building a digital company" conducted by PricewaterhouseCoopers (PwC) in 2016. Over the course of five years, the percentage rate of digitization in those organizations will rise from thirty-three to seventy-two percent. Furthermore, those businesses intend to spend five percent of their profits to increase their investment in digital tools. The report demonstrates the manageable edge of advantage the transformation provides to Asian companies, such as raising revenue (thirty-nine percent), increasing manufacturing efficiency (sixty-eight percent), and lowering production costs (fifty-seven percent).

Some experts have developed methods to determine the level of participation of countries in the digital transformation process, placing emphasis on both the level of technology adoption and other factors such as the quality of institutions, the quality of human resources, and the level of entrepreneurship. In the methodology, technology is quantified by the digital adoption index (DAI). Businesses, citizens, and governments represent three sub-indices, each of which is given equal weight. The DAI is composed of the following sub-indicators: It is calculated as follows: $DAI (\text{economics}) = DAI (\text{companies}) + DAI (\text{people}) + DAI (\text{Government})$. The report from the World Bank rates nations in various stages of the digital transformation process using the DAI technique. In order of increasing degree of digital transformation, countries all over the world have been categorized into three groups: (1) just getting started, (2) transition, and (3) converted. And Vietnam is defined as a country that is in the transitional stage of the digital transformation process, according to this classification. However, despite the fact that Vietnam has a comparatively favorable position in comparison to other countries with similar levels of development, the country is still in the transitional stage of the digitization process and will require significant work to attain its full potential in this regard. In terms of the ability of enterprises to absorb technology, a recent study conducted by the Ministry of Industry and Trade on the readiness of enterprises in the industry to approach the industrial revolution revealed that only a small percentage of Vietnam's industrial enterprises have begun to apply typical technologies of the technology revolution. The number of Vietnam's company firms that have access to digital technologies has increased in recent years, despite the fact that the number was

still small overall. Thus, manufacturing firms owned by Vietnamese enterprises and brands find it difficult to compete with other manufacturers throughout the world in direct competition.

According to the report of The Manufacturer about the Digital Transformation in 2021, because of the influence of the Covid-19, sixty-seven percent of the manager push the evolution of digital project on a new level, and ninety-two percent of them find that is “Effective operation improvement” is the most priority and only time is the impediments to digital adoption.

Digital transformation trend in the manufacturing industry is mainly focus on some core mission which include improve the effective in operation, production recovery ability, saving cost, increase customer satisfaction and improve the process performance.

According to that, several digital support manufacturing company to achieve their target are:

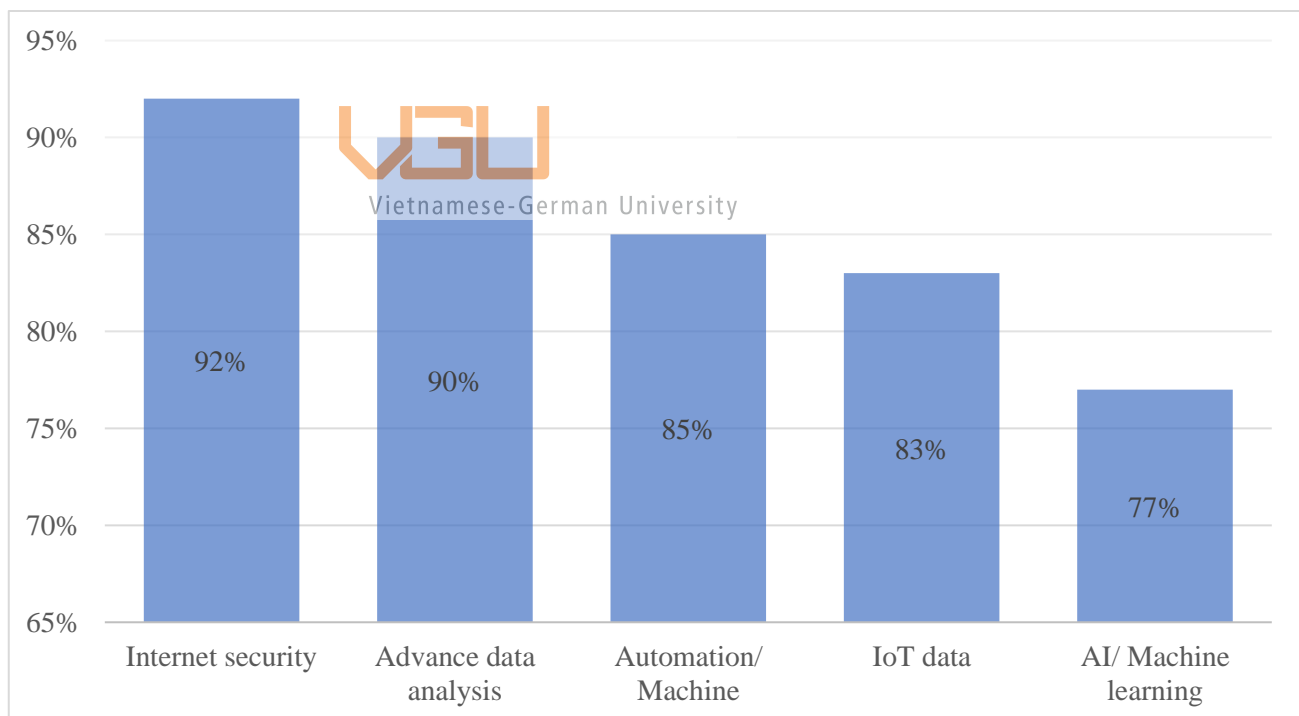


Figure 1. Bar chart shows the percentage of digital support in digital transformation

Internet security is a mix of rules and tools to assure the safety of the information processing progress, a technique to manage data safety, and other technology against cyber-attacks. Nowadays, many businesses make use of modern technology to boost the flexibility, automation capability, and adaptability capability of their processes in real-

time. In order to safeguard their equipment from cyber threats, they must devote greater resources to information security efforts.

With the introduction of current technologies such as the Internet of Things, data collection has grown more convenient and is now used all over the world. Eighty-one percent of firms feel that one hour of downtime will cost them at least \$100,000 USD, and thirty-three percent say that one hour of downtime will cost them up to one million dollars, according to a survey conducted by the ITIC (Information Technology Industry Council). As a result, the use of technology, data to precisely characterize any faults and to provide a prediction about the status and a schedule for planned maintenance assist them in maintaining the continuity of their operations.

The use of automation through the use of robots (RPA – Robotic Process Automation) has become increasingly popular in recent years, particularly in manufacturing production, with the highest priority being placed on cost reduction, maximization of operation, improvement of customer satisfaction, defect reduction, and more efficient control system operation. In 2021, the expected expenditure for those technologies (RPA) will reach at least 2.9 billion USD, according to the RPA (Forrester). The use of robotic process automation (RPA) was a critical factor in determining the feasibility of a digital transformation initiative. The project's implementation is made possible by automating the aforementioned laborious tasks and increasing production rates.

Even though the Internet of Things (IoT) has been launched and used by many enterprises for many years, this technology is still at the top of the list of digital transformation technologies that are generally recognized. According to a study conducted by the MPI Group, thirty-one percent of today's operating processes are comprised of a combination of embedded software systems. Furthermore, 34% of manufacturers intend to integrate Internet of Things technologies into their manufacturing processes, with 32% intending to include IoT technology into their goods.

Example: F.S Inc (a famous solar panel manufacturer over the world from USA), for example, employs a barcode system to establish where a panel is in the assembly line and which products have been scrapped, altered, or otherwise fit the criteria.

Furthermore, this company employs a large number of digital technologies to assist in their manufacturing, such as automated thickness measurement tools or at wet lines,

they use machines to clean the panel rather than physical labor. Besides that, by employing the barcode system to control their panel, they will have an online data system that can be used for analyzing to make changes. The utilization of digital technology, which automates the majority of their procedures, has enabled the F.S to achieve such a high rate and productivity from solar panels. In general, over the last few decades, the application of digital technologies, as well as automation, have shown to be incredibly beneficial instruments in aiding production optimization, from defect minimization to downtime reduction to eliminating the needless time, among other things.

In the dissertation, the student will discuss the benefit of the Control of Suspect Parts (CoSP) system, which is created to systematically manage suspected parts instead of manually in bearings manufacturing.

1. The general of the production lines

In the thesis, the student will research the Schaeffler corporation, a bearing manufacture manufacturing company from German. In this corporation, there are various varieties of bearings that have been created and used by many corporations over the world widely such as Honda, Piaggio, etc. In a manufacturing facility with a lot of items being produced, there will be a ton of issues occurring on numerous lines in the overall firm effect to not only the quality of the products but also have a terrible influent on human resources. This will be examined in greater detail in the situation presented below. The dissertation will largely focus on the line in which grinding, making of rollers, manufacturing of retainers, and assembly processing steps. Below is the process flow chart for the bearing manufacturer.

To produce bearings, the manufacturer has six primary states:

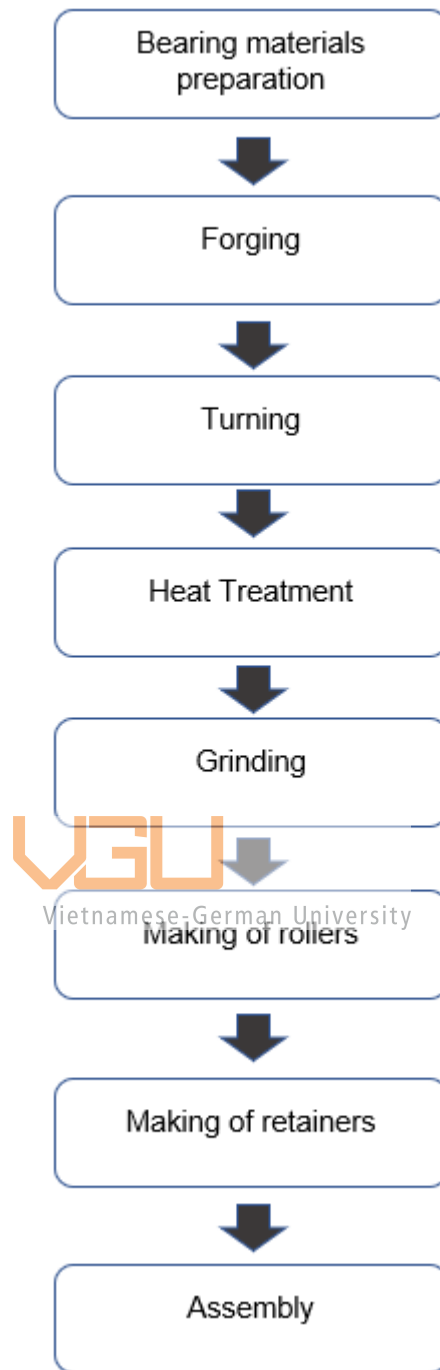


Figure 2. The typical manufacturing process of a bearing (UXGNEP, 2017)

The primary material for producing components in a tapered roller bearing, precision ball bearings, and roller bearing is 52100 chrome steel. Bearing's element includes bearing inner, outer rings, balls, and rollers. The standard chemical composition of chromium steel can be different in various countries and regions.

Firstly, the rings start with the forging and turning station, forming a shape at the soft state. Then it will be heated at the heat treatment station to become the hard rings. In the following steps, depending on the specification of the production order, the rings need to be grinded to meet the required specification. And then, with ground rings, rollers, and retainers, they are combined as the assembly process's final products.



Figure 3. The structure of Tapered Roller Bearing Products (Ackermann, 2020)



Figure 4. Tapered Roller Bearing (Ackermann, 2020)

2. Introduction to the PDCA Cycle

The quality tool PDCA cycle, which is also called as Shewhart cycle, is a lean manufacturing technique that Walter A. Shewhart devised in 1930. But William Edward Deming was the person who refined this methodology to a new version which was used internationally all over the world in 1950. That is why this process is termed the Deming cycle too. When it was first launched, the PDCA cycle was known as a method used to control the product's quality. The approach was created to be a continuous development tool in manufacturing. Many authors identify the PDCA cycle as a non-stop improvement technique due to its qualities, which focus on promoting continuous learning and creativity. PDCA includes four stages:

Plan: In this stage, the problem will be raised to define continuous improvement. By describing the current problems through examined data, we can allocate the priorities of the concerns. Then we continued with the reason for worry, suggested a method to remedy the situation.

Do: The goal of this stage is to implement the plan that has been put out from the previous step.

Check: In this stage, the outcome from the second step will be analyzed. Using the data that the student has supplied in the plan before comparing with the result after following the action plan to decide whether the goal was attained. Through the outcome, we have learned to give a conclusion and prepare for the following action.

Act: In this stage, the author determines the change of system and training to standardize the improvement, maintain monitoring the results for continuous improvement. Through study from the case, we may define the following improvement possibilities if the outcomes do not satisfy the standards or others problem occurs unexpectedly.

Many authors feel PDCA is more than merely a quality tool. The PDCA cycle is a form of continuous improvement technique utilized in the manufacturing sector. The reason why this methodology is highly suggested by many authors is that when the cycle has been started, it will produce more improvement for the process.

3. Flowchart

In the dissertation, the student also employs flowcharts to visualize the workflow for the work process in manufacturing. This type of quality tool is employed since it is easy to grasp and standardize. In general, a flowchart is a set of drawings that illustrate the workflow of a process. There this tool uses numerous symbols to present steps in a graphic, such as a rectangle stand for the activity or phase in the process. Oval, circles symbolize the start and end of the process. And the diamond is used to signify the step that needs to make a decision, and the arrow assigns the sequence of phases in the process. The flowchart has various advantages such as:

- It indicates the sequence of steps to complete the procedure.
- It illustrates the link between stages.
- It highlights transparency, place to place, and person to person.

4. Pareto Chart

A Pareto chart is a form of bar chart which have numbers of the bar, and each of them denotes a distinct type of category or list of an issue. The Pareto chart is frequently used to depict the distribution frequency of the data in the list of issues. And the chart order will be descended from left to right, and the line shows the proportion of the frequency. The tallest bar in the series represents the problem with the highest frequency rate. This form of chart helps the author to identify the frequency of the problem in the categories; that is the reason why this type of chart is typically being picked as one of the most useful charts in quality improvement. The advantages of the Pareto graphic are:

- It separates an issue into categories.
- It points out the most categories that have the largest impact on a problem => so that we are able to focus on solving the major problem instead of the inconsequential ones.

II. THE PDCA CYCLE

1. Plan

In the following chapter, the student will start the first stage of the PDCA cycle with the planning step. In this stage, the planning phase will go over the project charter to establish the scope and the relevant personnel in the project. Then the author follows with the problem description and then the proposed approach to clarify the current status of the issue and the methodology that has been employed to fix it. After the problem and solution of the problem have been defined, the student follows with the method used to study the performance of the outcomes of the proposed method.

1.1. Project charter

- **Definition:**

In general, a project charter is a brief piece of documentation that contains all of the project's pertinent information, such as the objectives, the process by which it will be carried out, and the persons involved. This is a critical component of planning because it will be used throughout the project to keep everything on schedule and on budget.

- **Project name:** Efficiency improvement for control of suspicious parts
- **Initial situation:**
 - Using paperwork to track the scrap part => No data connection to SAP
 - No systemic data recorded to analyze and improve the process
 - No trigger point/system to provide the quick quality reaction plan
- **Objectives:**
 - Use the system as a quick response quality control in the process to eliminate failures.
 - Use the system's data to analyze and improve the process.
 - Follow up with the project by using the PDCA cycle for continuous improvement.
 - Reduce downtime of solving suspicious parts
 - Increase the data transparency
 - Increase the effectiveness of handling suspected parts => clear WIP in stock area => limit failure cost due to stack parts in the stock area for a long time

- Improve the end-user satisfaction when applying the digital tool to production
- Reduce the workload of the operator by applying the web-based system
- **The main stakeholders:**
 - Q-segment
 - Quality Assurance Engineer
 - Web-based Developer
 - Inspector (End-user)
 - Operator (End-user)

1.2. Problem definition

1.2.1. Current problem

Every time a problem occurs, the product does not fulfill the specifications of the production orders. For example, a bore out of diameter, an incorrect assembly group, experiment or trial components, and so on are all examples of issues. It is necessary to keep pieces in a separate location. The operator needs to write a paper called “Nonconformity tag” with the time and date, part number, manufacturing order, amount of nonconformity part, etc. and put it on the basket of elements. After that, it will be transferred to a different site for archiving, waiting to finalize the decision. This nonconformity tag will be used to identify and track suspicious parts. The data will then be analyzed after deciding details for improvement, avoiding making the same mistakes in the future.

The operator will call the inspector (who accounts for the nonconformity portion) to report the issue. The inspector will report straight to the Q-segment (manager of the line that manufactures that component) about the problem. The manager must invest time to go to the segregated area to examine all the suspicious lists. This was a tremendous time that has been squandered. Besides time-wasting, data are written on the tag generally are partial or absent or cannot be read due to hand-written difficulties.

Until the manager has examined the pieces, they will need a short meeting on the floor between the relevant team and a verbal conversation. Without systematic might cause missing or misalign information as there is no centralized platform to record all action plans.

After the debate, the final decision will be delivered by email or phone, or even just through verbal dialogue. This will lead to no recorded data for a final choice, email or message will lose after months or years and impossible to discover when we need to track data for analysis or improvement.

Through the existing company’s process, we can define various drawbacks:

Security issues: regardless of size, for each business is vital to secure its data and other valuable assets. One of the most significant information security concerns for organizations is paper since printed papers may be easily lost, mistreated, or destroyed. In contrast, digital data might be encrypted and safely stored in hard drives or electronic devices.

Limit communication and collaboration: when dealing with paper documents, cooperation is exceedingly challenging. Suppose many department heads need to develop a standard document. In that case, they must have several copies printed, make all the required adjustments individually, and then share their version before starting to work on the ultimate version. Digital document management solutions allow users to interact in a way that is straightforward and rapid. They may also trace all the modifications done.

Time consumption: working with paper documentation takes a lot of time since we have to write it manually instead of typing. Also, to check the pieces, managers need to check by themselves all the suspicious lists.

Table 1. Record of actual Time of solving suspect parts

The actual time of solving suspect parts					
Areal investigated: ISO Line					
No.	PROCESS STEP	OWNER	MAN	DURATION	Note/ Problem
1	Manually input suspects' information on paper	Operator	1	0:05:00	_Data input is usually incomplete, incorrect _Time consuming
2	Operator report to the inspector	Operator	1	0:02:00	

3	Inspector report to Q-segment	Inspector	1	0:02:00	
4	Q-segment go to check the suspect parts at stored area	Q-segment	1	0:10:00 – 30 days or more	<ul style="list-style-type: none"> _Depend on the workload of the Q-segment. _Sometimes, they forgot about the suspect parts => parts being corrosion, rust => scrap
5	Verbally discuss or email	Relevant team	6	0:10:00 – 30 days or more	<ul style="list-style-type: none"> _Misalign information due to no centralized platform _No record of the action plan
6	Releasing parts through email/ phone/ verbally discuss	Q-segment	1	0:02:00	<ul style="list-style-type: none"> _No record of final decision _Data lost after months or years _No evidence of released parts
7	Q-segment input data into excel for analysis and report	Q-segment	1	0:30:00	<ul style="list-style-type: none"> _Missing data due to loss of nonconformity tag _Time consuming due to input manually _Excel file can be wrong due to manually input _Excel file can be lost after a period of Time

The table above was the recording of real-time solving suspect parts. It was clear from the table that there were a lot of gaps and dead time owing to objective and subjective factors. Especially since the time, it takes to solve the component in stages four and five might be delayed by up to thirty days or more. The time spent on this activity in step 4 or 5 was determined by the person in charge of the line where the problems occurred. However, because the workload of the Q-segment was too heavy, they focused too much on solving problems that occurred on the line, such as tool failure, improving tool downtime, and so on. It is easy to forget about the suspicious parts if there are no tools or systems to remind, escalate, and solve them. And this was the primary issue that might lead aspects with only fixable flaws such as spots, track diameter +, etc., to become unfixable due to stacking many parts in the storage region.

Below is the flowchart for the current steps in solving suspicious parts.

_Operator/Inspector is manually input suspected information such as date, defect, PO, material, affected quantity in the nonconformity tag.

- This takes around 3-5 minutes.
- Usually data are uncompleted, incorrect
- Handwriting of some people hard to read



_All parts in isolate area are tracked by manual papers/personal excel files without systemic tracking/

- Incomplete/missing data often happened.
- Manager, Engineers must go to the area to see all the suspected list.
- Time solving depend on the workload of Q-segment.
- Easy to forget.



_Verbally discuss or email

_Manual follow up and tracking

- No system to track evidence or result
- Often missing or misalign information since there is no centralized platform to record the action plans.



_Releasing parts through email/phone/verbally discuss

- No record of final decision.
- Data lost after months of years.
- No evidence of released link to the suspected part.



_Q-segment input data into personal excel file for analysis and report

- Incomplete data due to loss of nonconformity tag
- Time consuming because of manually input
- Excel file can be wrong by manually input
- Excel file can be loss after a period of time

The flowchart above depicts the current stage of the company's investigation into suspect parts. It is not intended to be comprehensive. The operator separates the suspicious parts from the excellent quality portions in the first stage after defining the suspicious components. The information about the part is then entered on a piece of paper known as a nonconformity tag by the operator. In most cases, it takes the workers three to five minutes to finish the data entry, yet the information is frequently partial or erroneous. Following that, the part will be stored in a stock area and will be tracked manually using paper or personal excel spreadsheets, as there will be no systematic tracking in place. As a result of this approach, several potentially salvageable parts that could have been reworked ended up being scrapped. Because of the high volume of work in the Q-segment, the parts are typically stacked in the stock area for an extended period of time without any escalation. Furthermore, it took an inordinate amount of time for the managers, Q-segment, to travel to the stock area and personally inspect every single one of the questionable parts on the list. After being discussed verbally or via email, the pieces were also made available via phone, email, or even just verbal discussion. This laborious process results in a lack of data and information when it comes time to trace the proof or outcome backwards, as we will need to do. Furthermore, because there was no centralized platform to track and document the

action plans, the information was frequently out of sync. In the final phase, the Q-segment must once again enter the data into the personal excel file in order to do an analysis and generate a report. However, because of the loss of the nonconformity tag, the data being entered was incomplete, and the excel file may be lost after a period of time has elapsed.

If the parts in the stored region are not solved, the quantity increases over time, day by day, week by week, and month by month. And this leads to several difficulties that may or may not be resolved, as well as the loss of a significant amount of time, which is regarded as money in the industrial manufacturing industry, to repair those parts. If the piece is piled too high in the storage area, it might develop scratches, deformities, bends, and distortions, among other problems.

One issue that may affect the failure cost is that several new defects which are not in the defect list have been found through time in manufacturing, but these new ones were being documented on paper only, and it was just used for correcting the issue at that time purpose only. When new problems develop, not only the inspector but also the Q-segment must spend a lot of time identifying, measuring, evaluate and clarifying the source of it. But this problem might happen again in the future, but since there was no recorded data or just written on paper, the Q-segment once again needs to invest time to “re-clarify” the issues. If the Q-segment needs to specify the problem again, it is termed redundant work.

Aside from the issues mentioned above, utilizing paper to capture data is very foggy in the digital industrial century. It is a waste of paper and directly impacts the environment, which goes against the industrial industry’s current focus on the future. Furthermore, there were months when the corporation received the failure cost from the segment without any description or the failure that could not be allocatable. Data was one of the most significant bits of information in modern industry. Because data allows the company to increase quality and production speed, which directly impacts a manufacturing company’s profit, the firm may address this issue by utilizing COSP’s digital tools.

The pie chart depicting the information that was provided is displayed below. There are several errors in manufacturing, but the student’s dissertation will concentrate on the flaws that can be corrected through the use of a web-based system rather than the

defects themselves. When seen as a pie chart, the defects generated by stacked items in the stock area as a result of miscommunication such as scratches and streaks, corrosion and rusting, deformed or distorted parts, and so on, account for around ten percent of the company’s internal failure cost. This type of flaw, which occurs on a monthly basis, can result in significant waste due to the fact that defects can be eliminated through the use of digital technologies. The student takes into account many failure costs that can be reduced by the system, such as failures that are not allocatable and scrap costs that cannot be allocated, which account for around ten percent of the total cost each month and can be reduced by the system. These problems are not caused by stack parts, but they manifest themselves in the majority of the months from January to July without any strategy, action, or attempt to restrict or prevent the faults because there is no documented data for the deficiencies. For example, according to the Q-segment, the faults were not in the system for the failure to be allocatable; thus, they normally handle it by experience rather than using a process-centered approach to tackle the problem. This was an emotional reaction, and such behavior should not be tolerated in a professional atmosphere, such as a manufacturing workplace, under any circumstances. And, in the case of scrap costs that were not allocatable, the cost was recorded on paper, but when the Q-segment was entered into the system, the paper was crumpled or otherwise lost. This was a big source of frustration when it came to data recording on paper, which was a common occurrence.

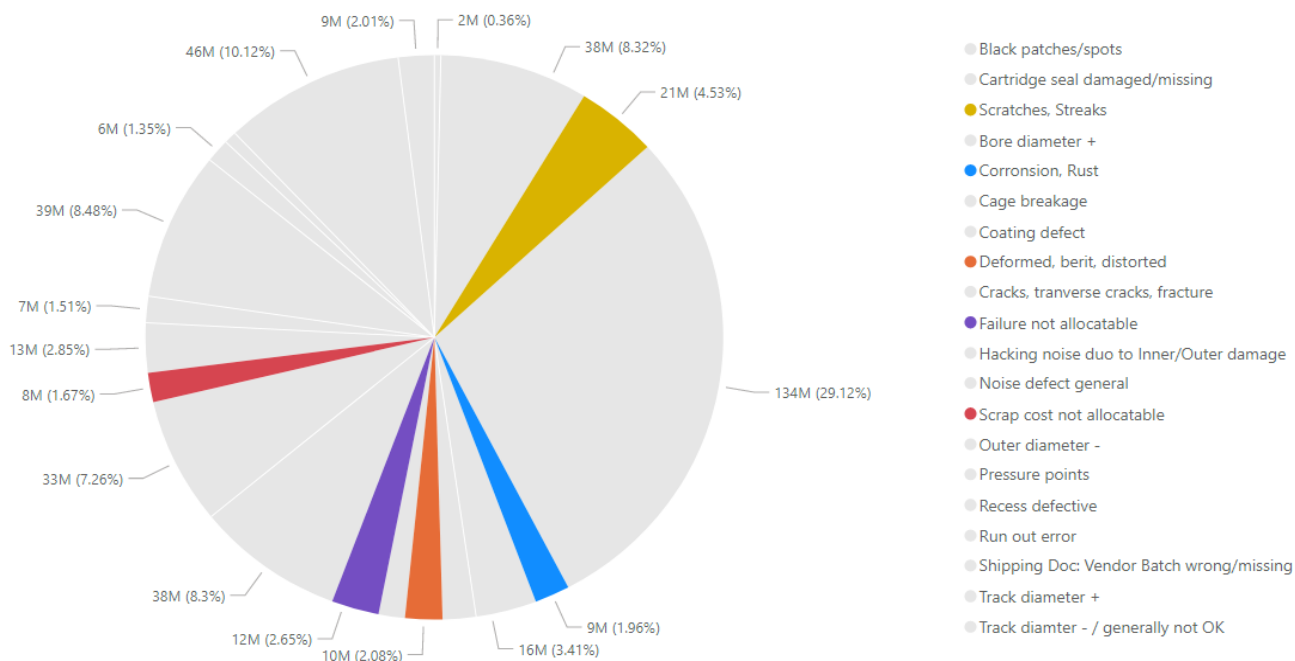


Figure 5. Pie chart for Internal Failure Cost 01.2021

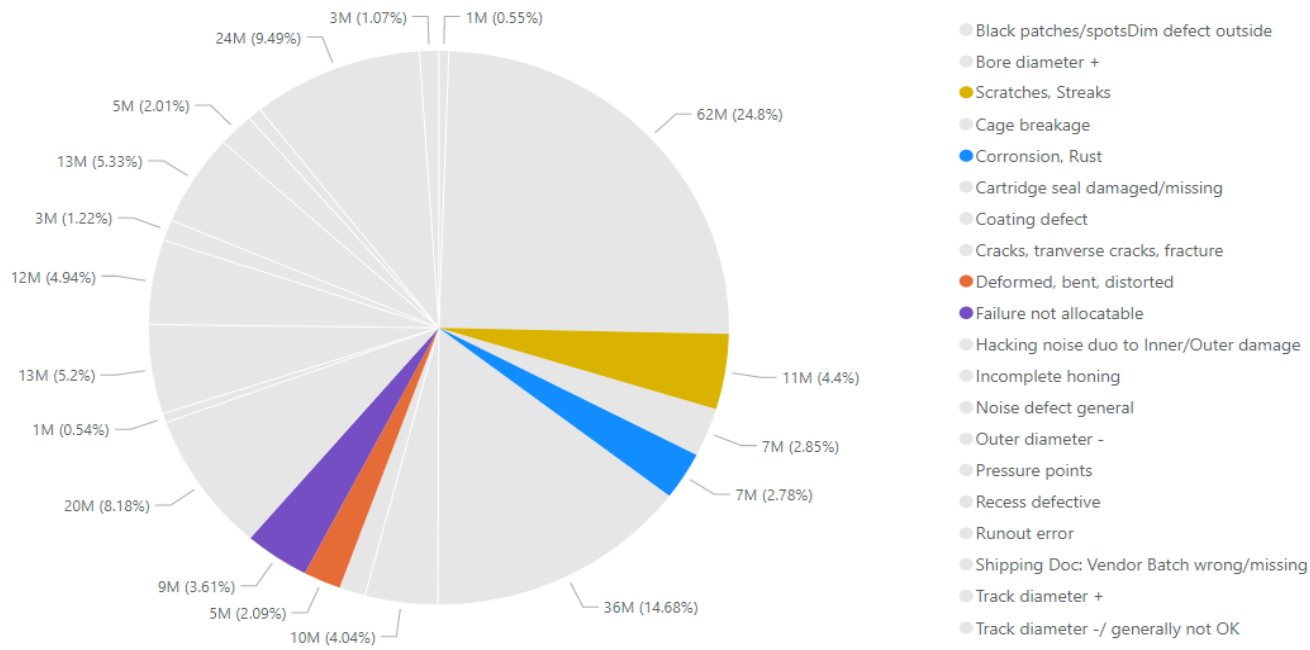


Figure 6. Pie chart for Internal Failure Cost 02.2021

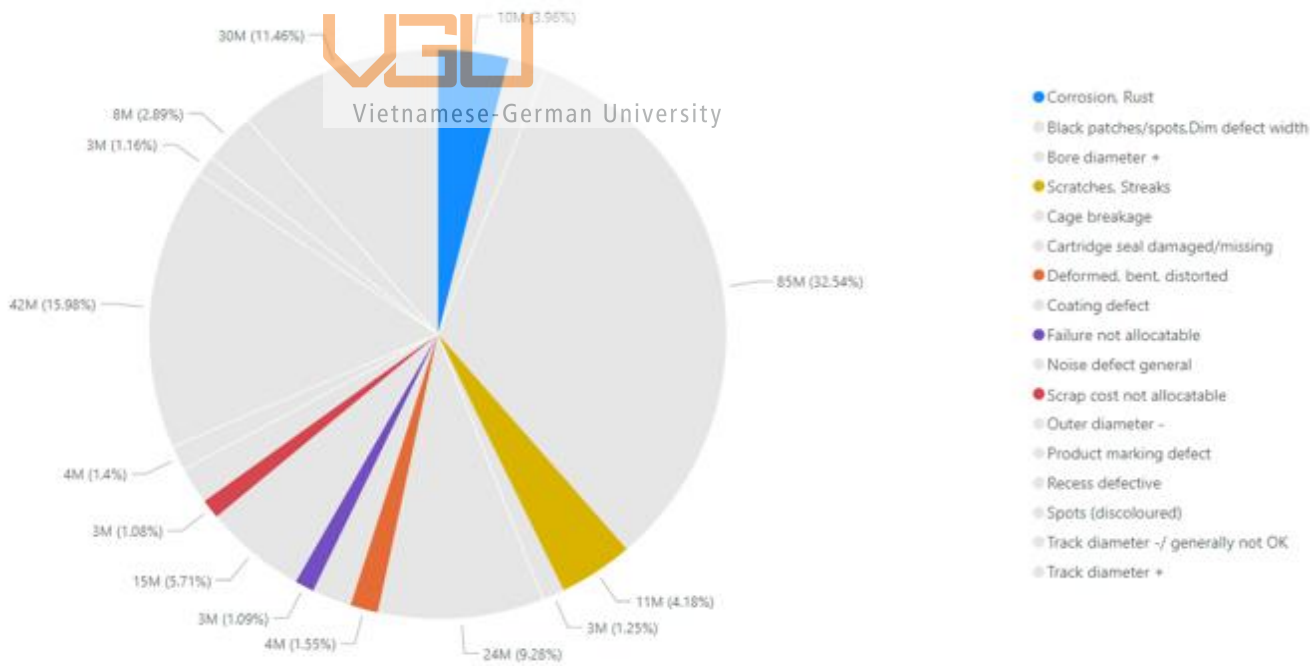


Figure 7. Pie chart for Internal Failure Cost 03.2021

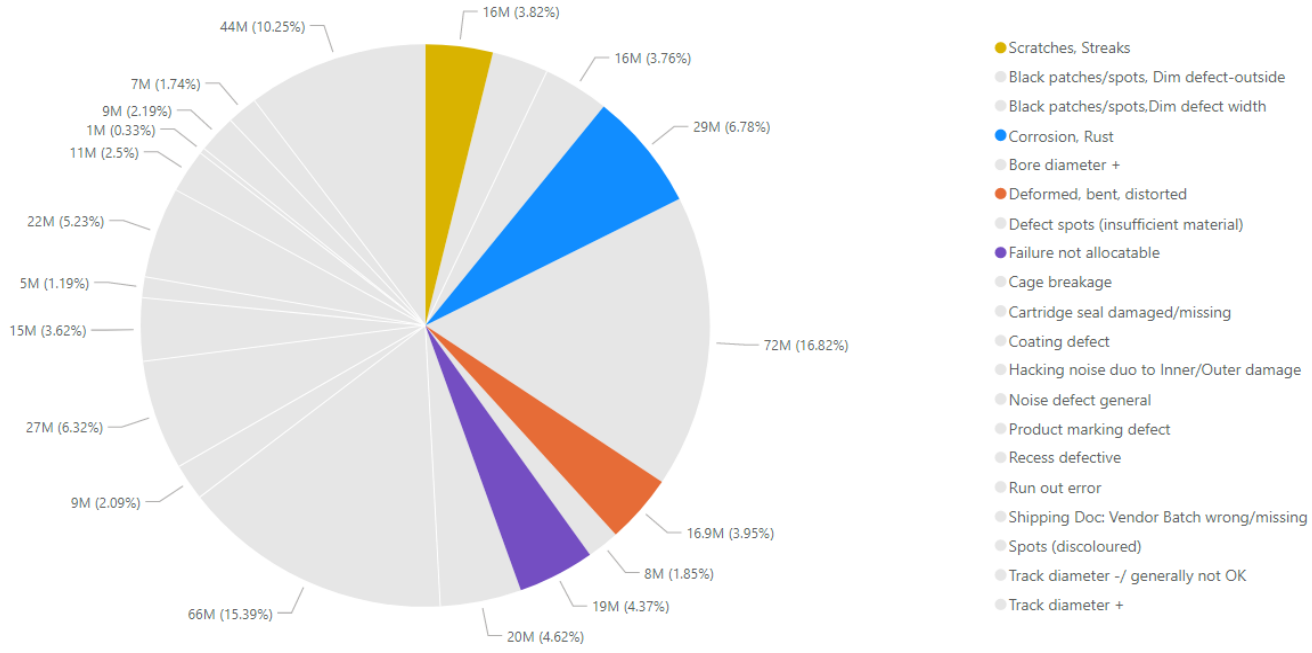


Figure 8. Pie chart for Internal Failure Cost 04.2021

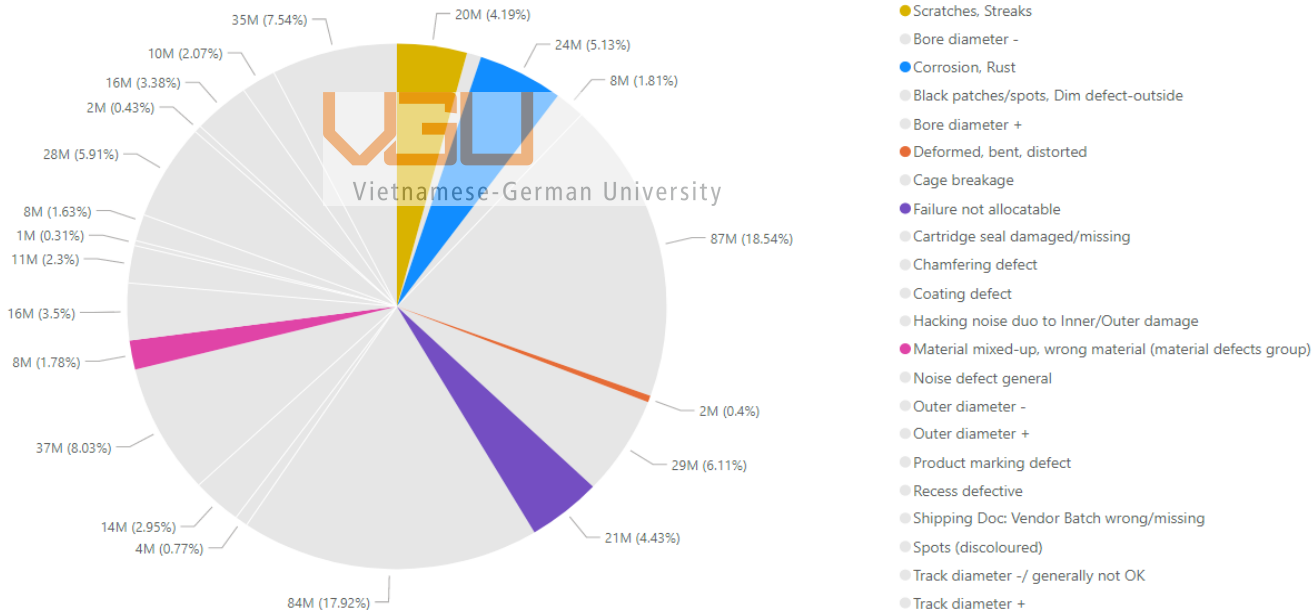


Figure 9. Pie chart for Internal Failure Cost 05.2021

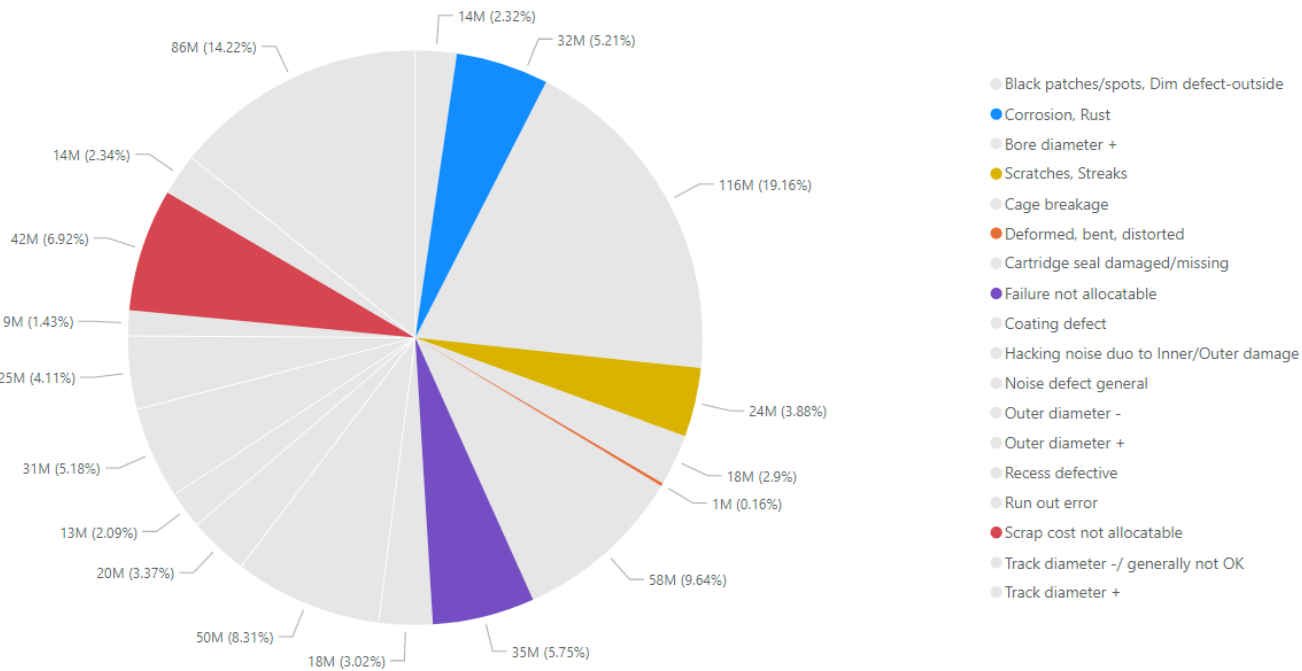


Figure 10. Pie chart for Internal Failure Cost 06.2021

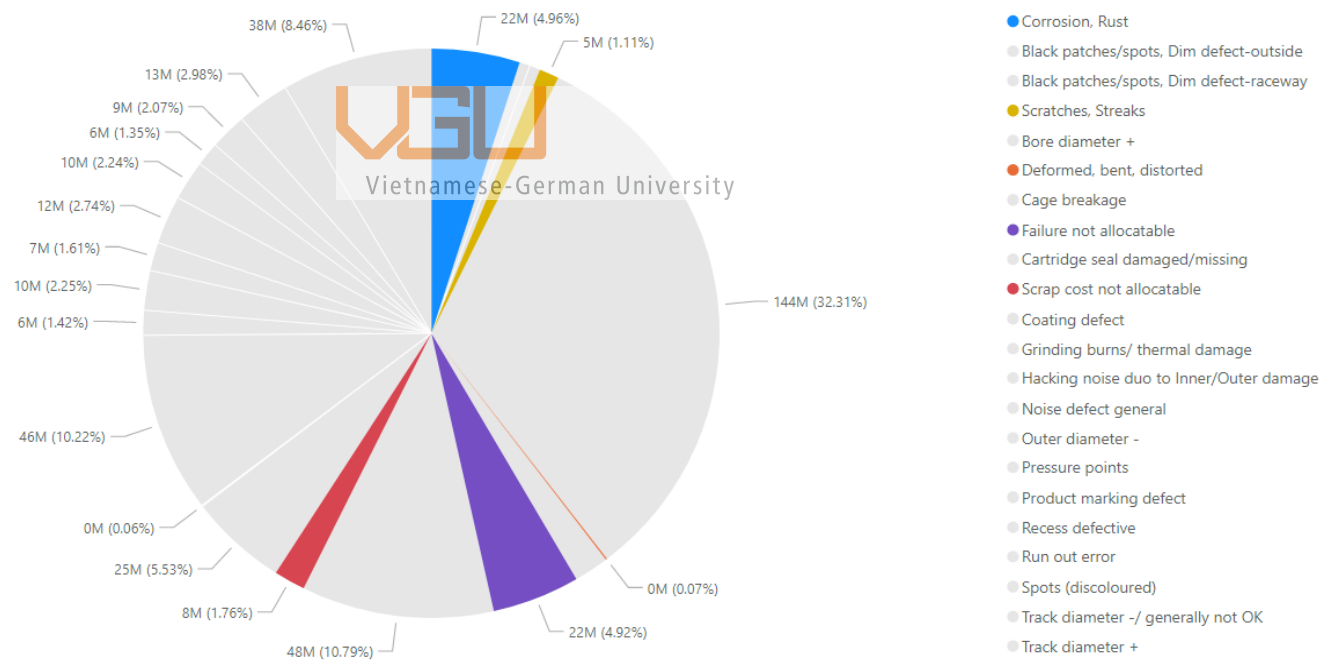


Figure 11. Pie chart for Internal Failure Cost 07.2021

The pie chart above depicts the percentage of defects that cost for failure cost in the company. As the list of components has revealed, there are a lot of defects that lead to failure costs. But in the dissertation, the student solely concentrates on minimizing the concerns that able to be improved as indicated above. This fault contributes for roughly fifteen percent of the entire cost, as figure 8 indicates. Corresponding to the column

chart, which indicates the frequency of percentage of the failure cost, these types of faults occur with the rate is monthly. But by employing the CoSP, the project mainly focuses on lowering the failure cost caused by stacked parts in the stock area as in figure 9 indicate scratches, streaks; deformed, warped; corrosion, rust. The project also attempts to decrease the two additional defects are "scrap cost not allocatable", "failure not allocatable" but these types of problems need long-term monitoring the clear if the system works successfully to reduce the cost caused by those.

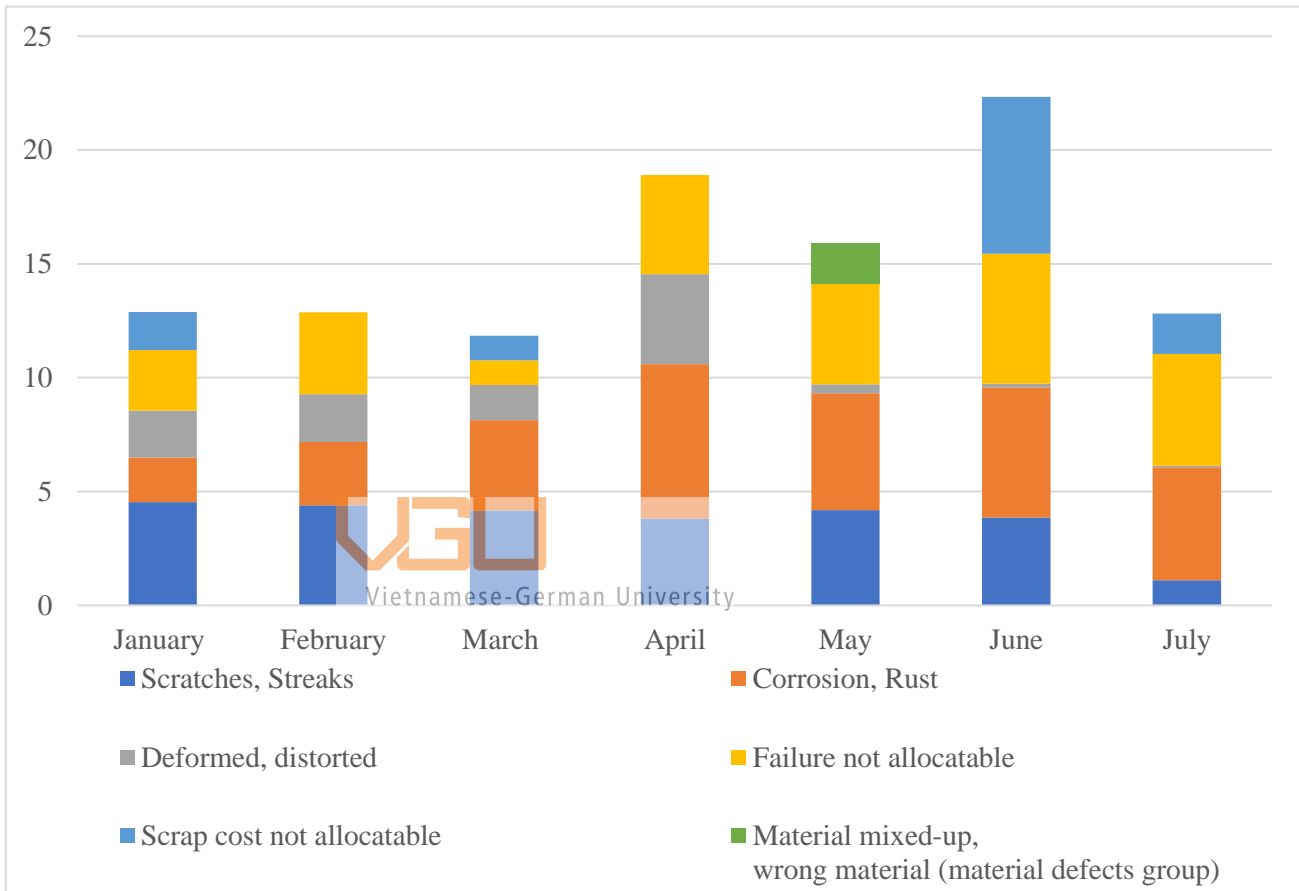


Figure 12. Column charts show the frequency of percentage of the failure cost

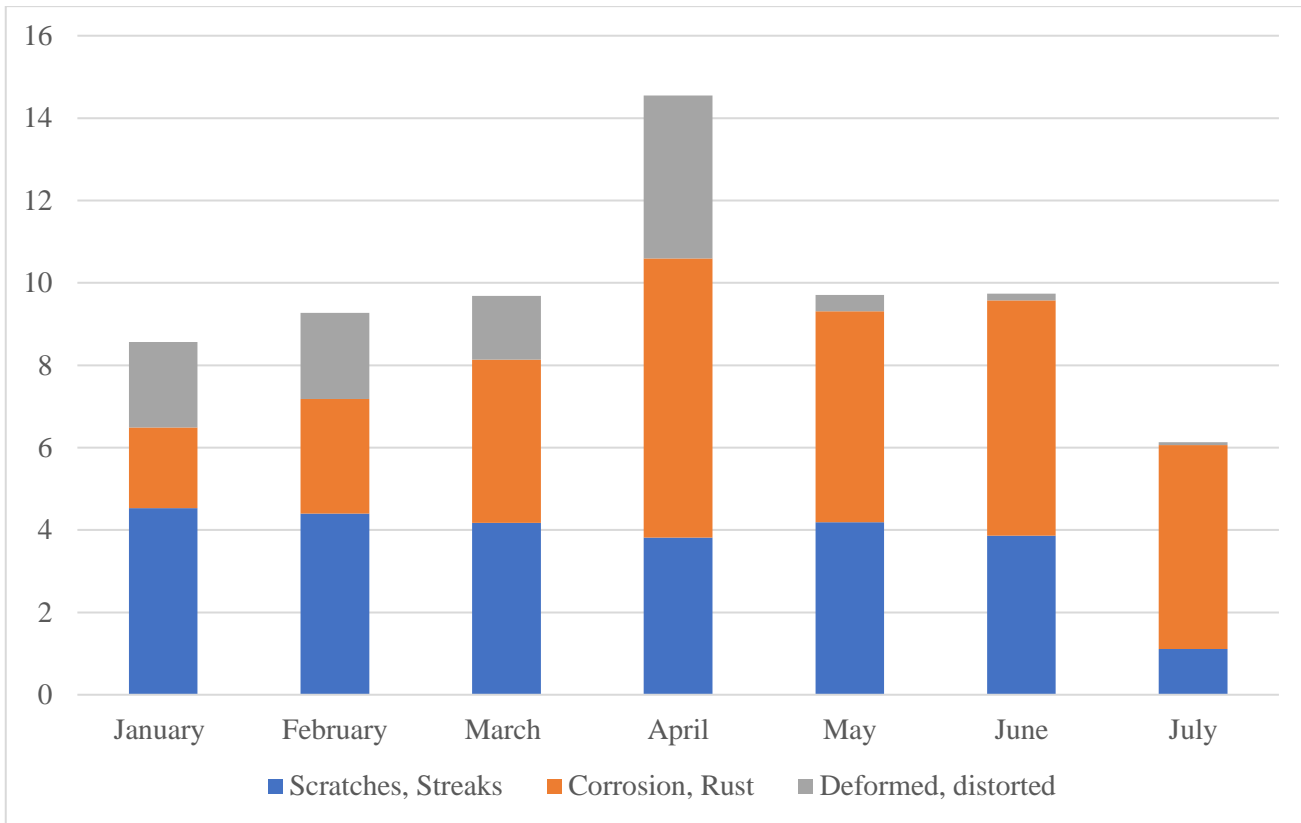


Figure 13. Column charts show the frequency of percentage of the failure

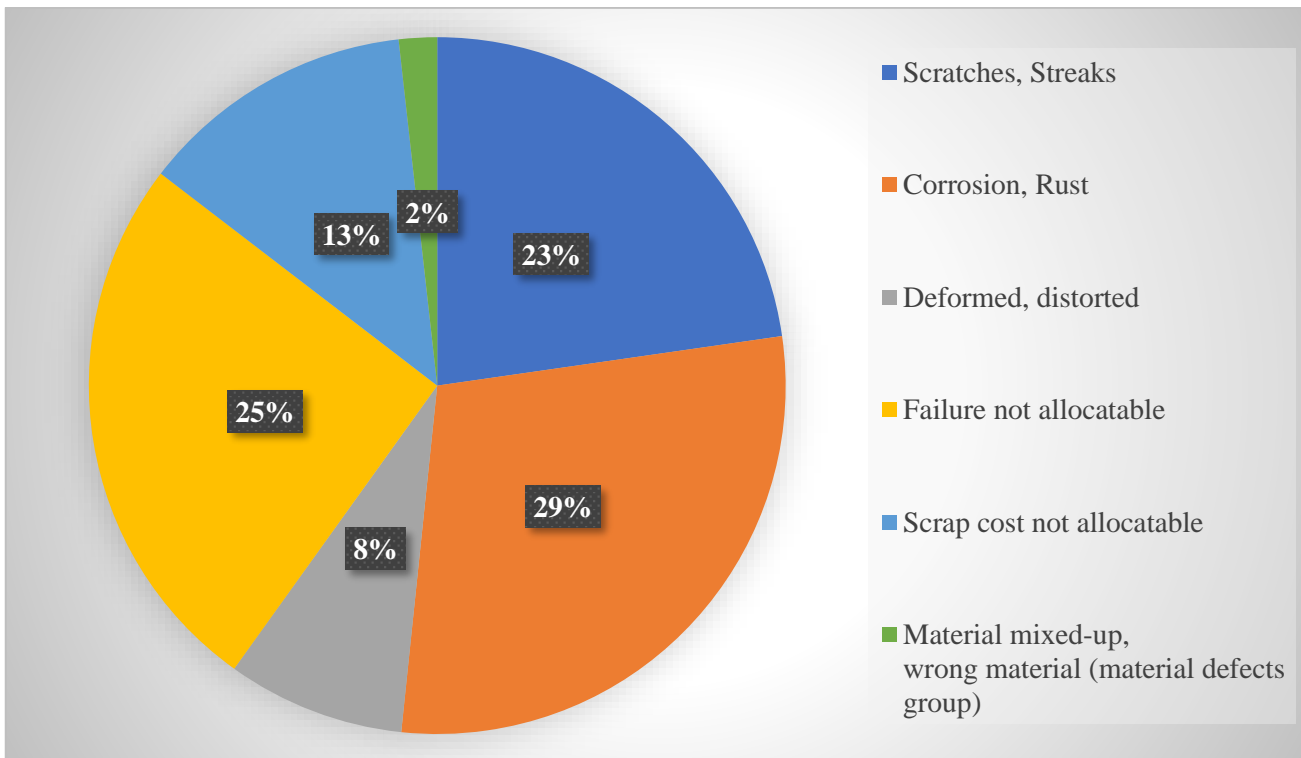


Figure 14. Pie chart for the cost able to improve through the system

In the three figures above, the failure cost represents the amount of money that can be saved by implementing the CoSP system. Figure 12 depicts the frequency of failure as a proportion of the failure cost for a total of six different flaws. FIGURE 13 illustrates the three problems on which the student concentrated most of his or her attention in the dissertation; these types of flaws were generated by the accumulation of stack components in the stock region. The student also takes into account the three remaining flaws: scrap cost that is not allocatable, failure that is not allocatable, and material that is mixed-up. The use of the CoSP system may also help to improve up since the data obtained when using the system may be used to study and improve these types of problems in the future. The percentage of each failure cost in terms of the total cost is represented by a pie chart. For the most part, defects produced by stack parts in the stock area account for 60% of all defects in the warehouse. The group of faults can be improved by analyzing and finding potential remedies for each case that accounts for forty percent of the total number of flaws collected on the system.

Through the column chart, the defects which students focus on in the dissertation are not even reduced through time but increase more in June. The frequency of the defects that occur relatively often creates an enormous waste of expense for the firm budget. The flaws created by stack part in the stock region include: (1) scratches, streaks; (2) deformed, distorted; (3) corrosion, rust. The frequency of these defects happens every month and accounts for around sixty percent of the failure cost. The cost that cannot be discovered owing to missing of the recorded data such as scrap costs not allocatable, material mixed up, improper material occurs every month from January to July account for roughly fourth percent. And the failure not allocatable is the defect the student deems to be investigated since despite the fault's cost might not reduce directly through the system. But through time, when the flaw repeat, the Q-segment provides a proposal for a similar defect that occurred in the past. By applying the CoSP, the Q-segment has decreased quite a lot of time for solving suspicious parts.

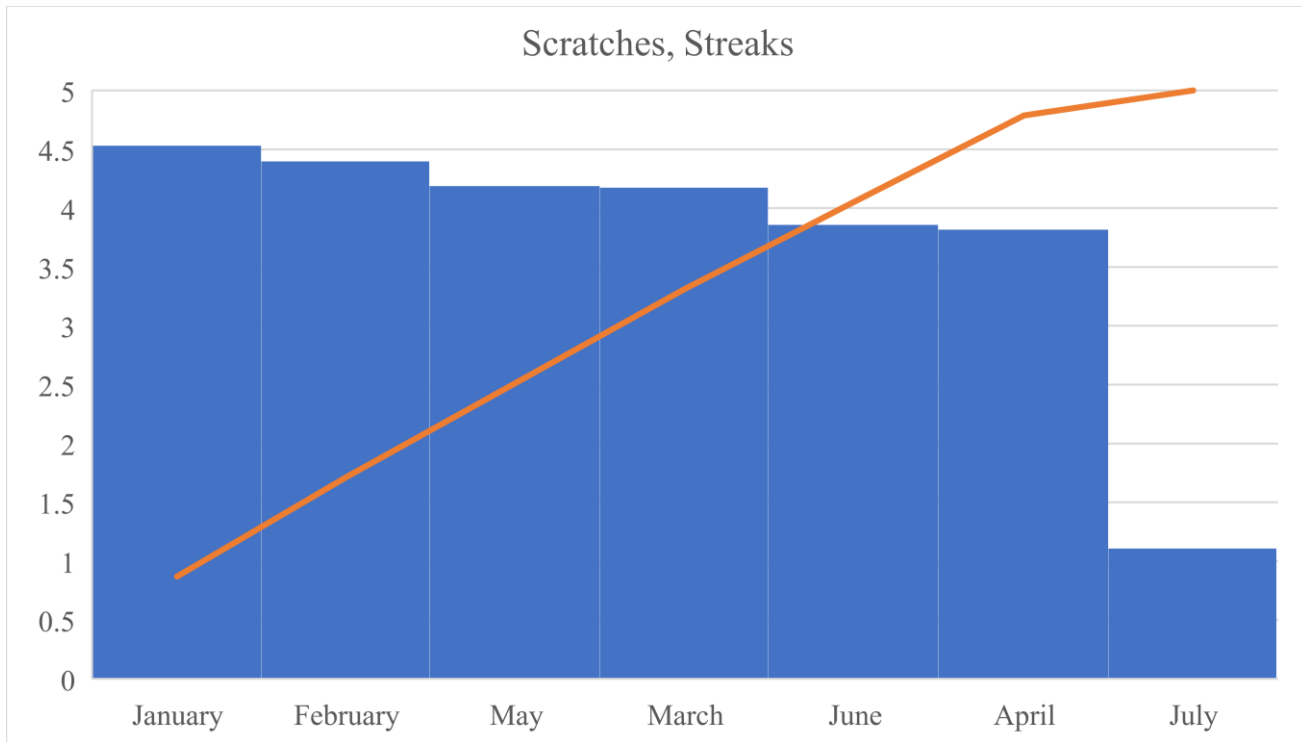


Figure 15. Pareto charts of the percentage of scratches, streaks defects each

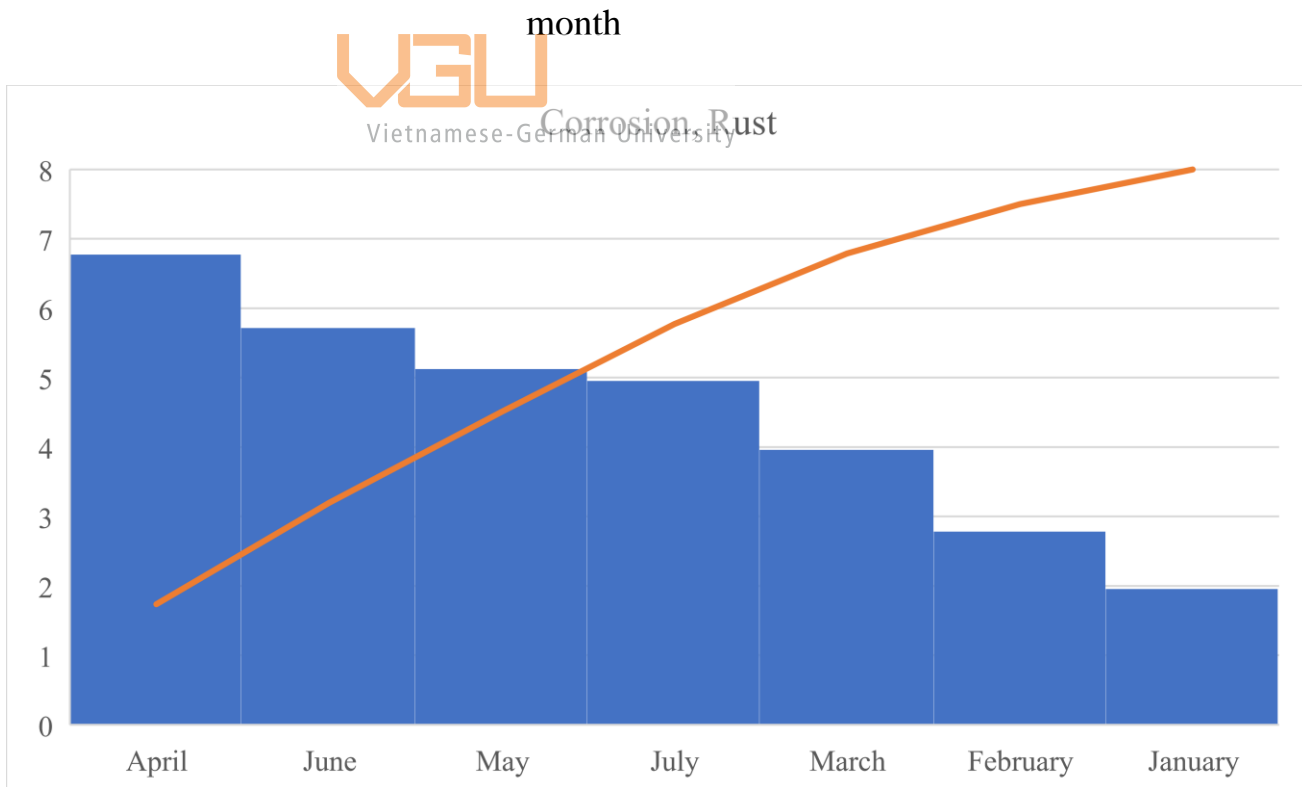


Figure 16. Pareto charts of the percentage of corrosion, rust defects each month

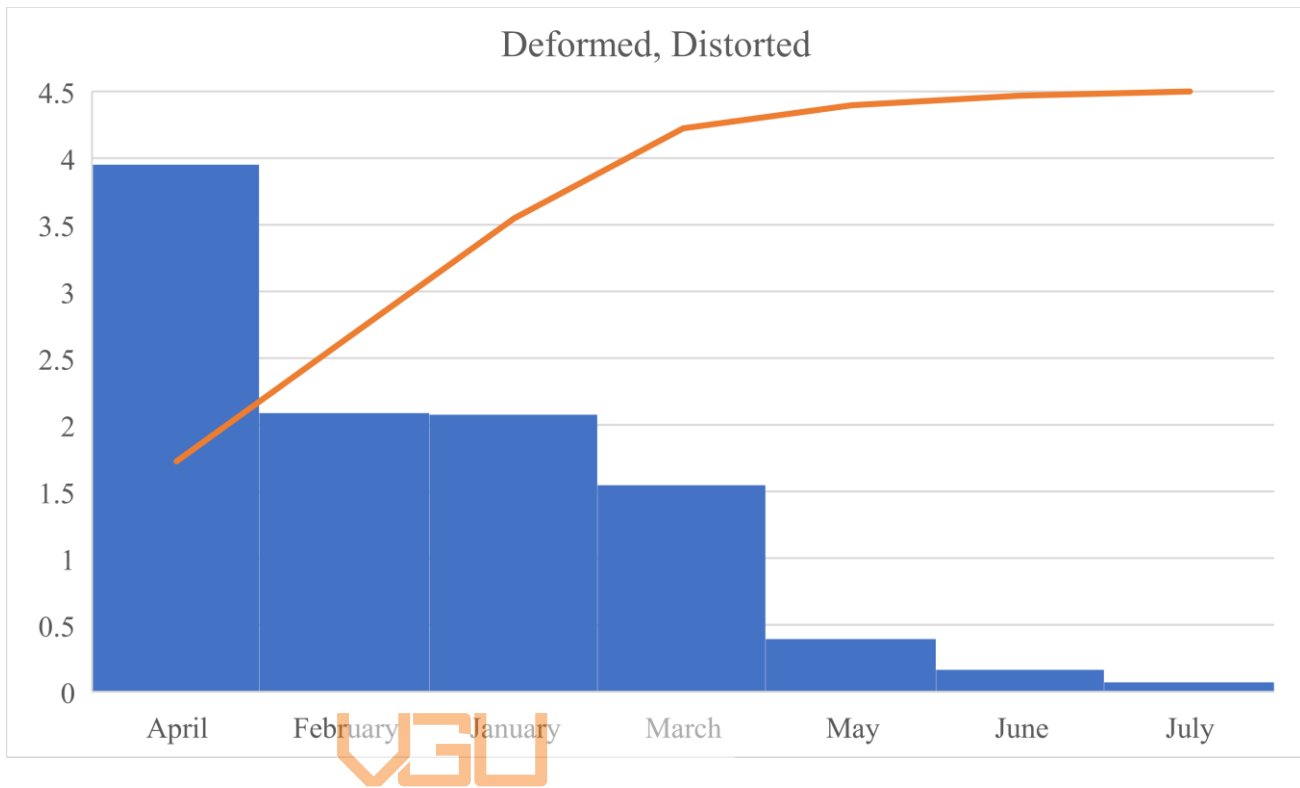


Figure 17. Pareto charts of the percentage of deformed, distorted defects each month

The three Pareto charts above illustrate the frequency of the failure that happens every month is generally uniform, notably the two defects corrosion, rust; scratches, streaks, with the proportion accounting around five percent each month. For the deformed flaw, the frequency is sporadic, with the peak being four percent in April and the lowest in July being approximately only 0.2 percent.

1.2.2. Proposed method

Creating a web-based system where we can store the data of quantities of suspicious pieces, defects, and through this system, the operators and managers can communicate online. The system will mainly focus on digitalizing the system by developing a web-based and user-centered application to control potentially non-conforming products (suspect parts).

Because this web-based solution is mainly automated, the operator's workload will be reduced. For example, under the old method, the operator would have to take the time to write "Nonconformity tag" on a piece of paper, then report to the inspector, who would then report to the management; otherwise, the manager would be unaware of the suspicious components. However, with this web-based system, the operator only has to enter a few essential pieces of information, such as the number of product orders, the number of processing steps, etc. The rest will be filled in automatically.

All suspicious components are monitored online on the CoSP website, complete with all relevant details and status. Additionally, everyone in the factory has access to a portal to follow the list of suspicious parts and their status. This provides significant benefits to the firm, such as increased data transparency and faster response times.

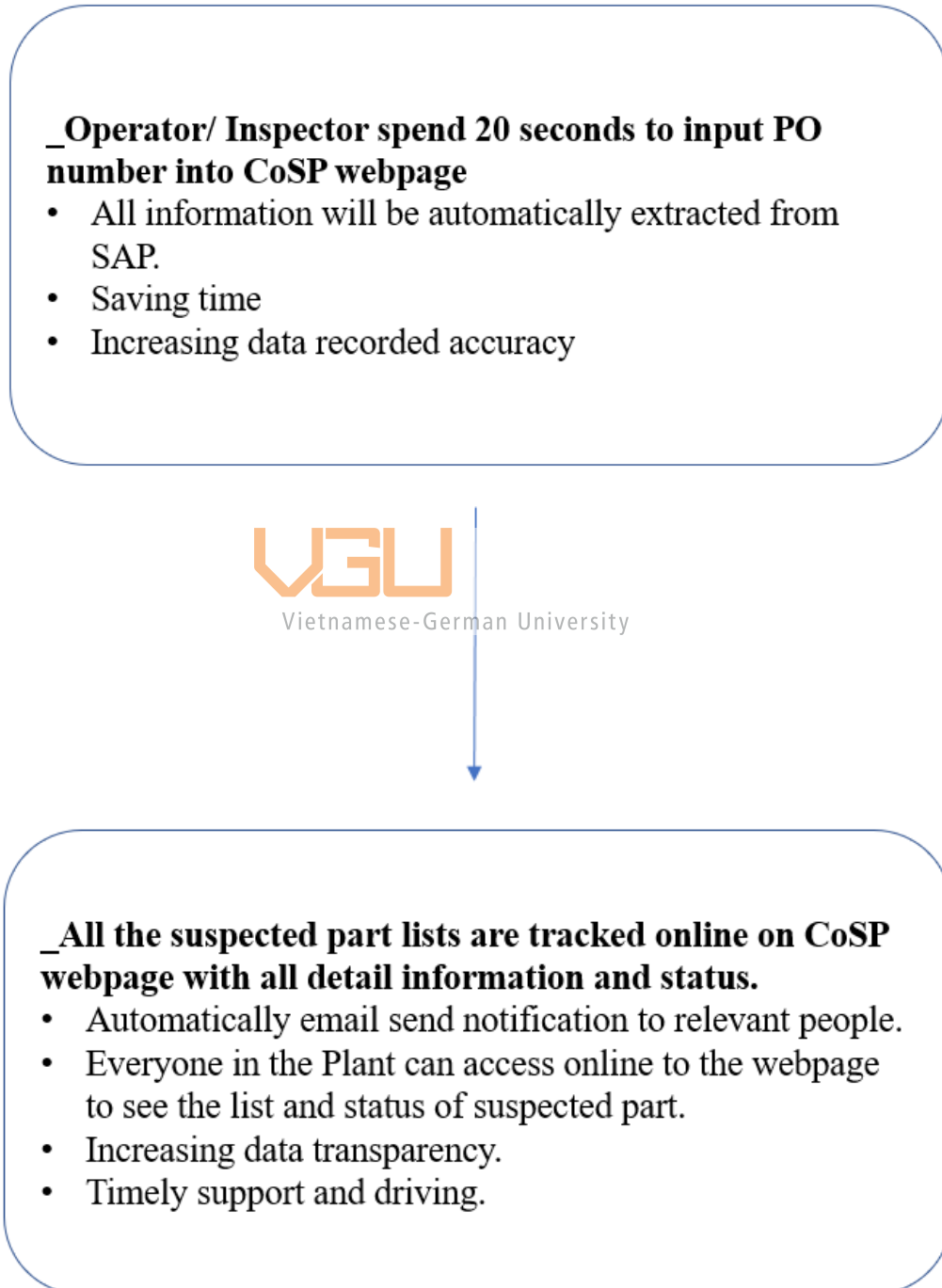
Furthermore, when the operator submits the report on CoSP, the system promptly notifies the decision-makers by sending an Email. If there is no response within twenty-four hours of the last escalation email, the automation escalation program will send another email to additional deciders/managers. We will enhance the efficacy of managing suspicious components by escalating after a short amount of time without a response, contributing to clearing WIP (Work in Process), and reducing downtime. And, after receiving the escalation, the manager may set numerous tasks for either investigating or resolving the concerns, which made this system extremely handy for both decision-makers and operators. The supervisor can also designate which operator will complete the duties. Also, request that the operator provide documents, photographs, or links as evidence.

Besides, after the operator concludes the task, the manager may double verify whether the outcome matched the requirements. And then decide to close the problem or assign the operator to another job to elucidate the concerns in more depth. The technology will archive data automatically, and this will affect the innovation of the firm. Through the attained data, individuals can create improvement and non-stop innovation. One other advantage that CoSP gives us is that when the identical issue arises in the future, the recommendation will emerge so that the deciders may reference to make a choice more efficiently and quickly. By this, we may save a lot of time and energy on other things.

After all the actions have been made, the final solution will be released through the system. The issue's status will be changed to green, and everyone will be informed

through automatic email. The decision is recorded on the webpage for analytical purposes and may be exported easily after months or years without any problem. This method not only safeguarded data more efficiently but also boosted the systematic tracking and storage operations.

Below is the flowchart for the proposed method:





Final release (scrap/special release/...) will be made on the system.

- Status will be changed, related people will be informed.
- Data will be tracked, and easily to summarized and exported after months or years.
- Increasing systemic tracking and storing activities.
- Protect data from lost/missing
- Evidence/ actions of released will be tracked.



Decisions are being recorded on the system for analysis

- Easy to access to review any time.
- Pop up suggestion decision of old cases when similar issues happens.
- Visualize the data with charts.

The flowchart above depicts the progression of the investigation of suspicious parts through the use of the proposed CoSP system. Instead of manually entering the system on paper after defining the suspect parts, the operators only need 20 seconds to input several key information such as the PO number, the number of parts, and so on, and the rest of the information will be fulfilled automatically. The system will then be able to track down all of the suspicious part lists, which will be available online. In addition, if the cases are not resolved within twenty-four hours, an automated escalation mail will be issued to the parties involved. Following the ruling, the system will send an email to all parties involved in the case to inform them of the outcome of the case. Furthermore, the data will be saved on the system so that the Q-segment can track it and export it as needed if necessary. It is also being used to assess and figure out new proposals for continual improvement based on the information gathered.

1.3. Introduction to the web-based system (CoSP)

CoSP stands for Control of Suspicious Part. This is an idea that was being proposed by a group of engineers in the Schaeffler firm. It was established to aim to regulate not only the quantity of the questionable parts being stored in the stock area but also the number of parts that were trashed in the company. Moreover, the project is planned to use as a recording data tool as it keeps all the information that the operator input and the choice that Q-segment has made on the system. This produces an online database that can be utilized for analyzing, continual improvement. Besides helping the Q-segment and inspector to manage the parts, the system's expectation is also utilized to promote the transparency in the company. This type of online stored information system expects to safeguard data from lost or missing or recorded evidence, activities of released portions more efficiently than paper.

The project was being submitted in June 2020 and was approved at the end of the same year. The web-based system was designed and launched to pilot in August 2021.

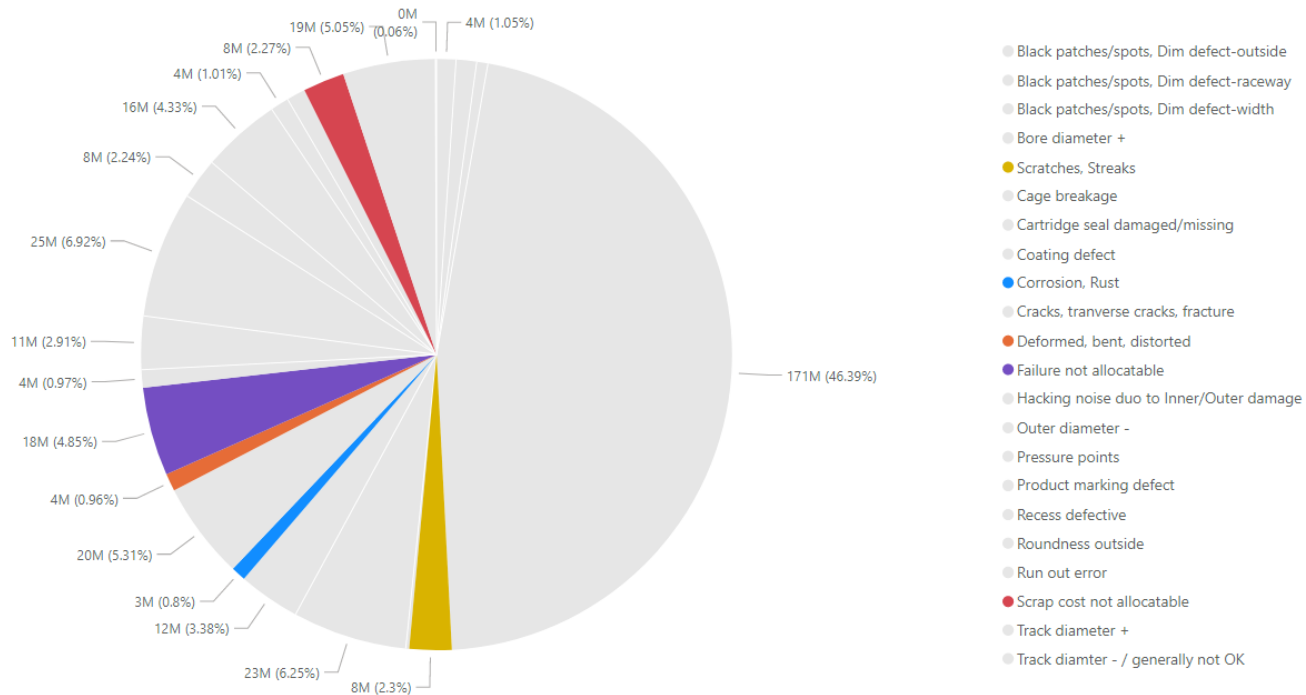


Figure 18. Pie chart for Internal Failure Cost 08.2021

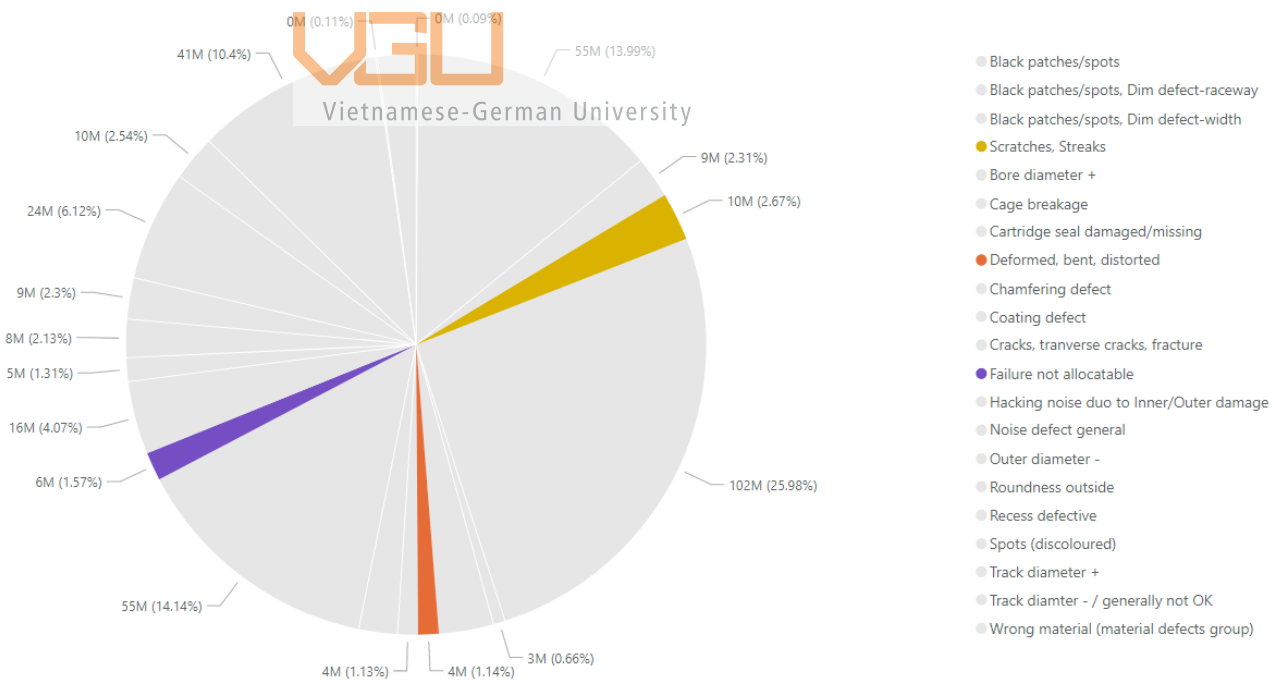


Figure 19. Pie chart for Internal Failure Cost 09.2021

In the first two months of piloting, the result seems to be grown in a positive direction. In totally, as the two pie charts in figure 13 and 14 shown, the percentage of failure cost which the dissertation has reduce from approximately fifteen percent each month to

11.18 percent in the August. This trend keeps continuing and approach 5.38 percent in the following month. In general, this is a big step in the first step of continuous improvement by applying digital to production.

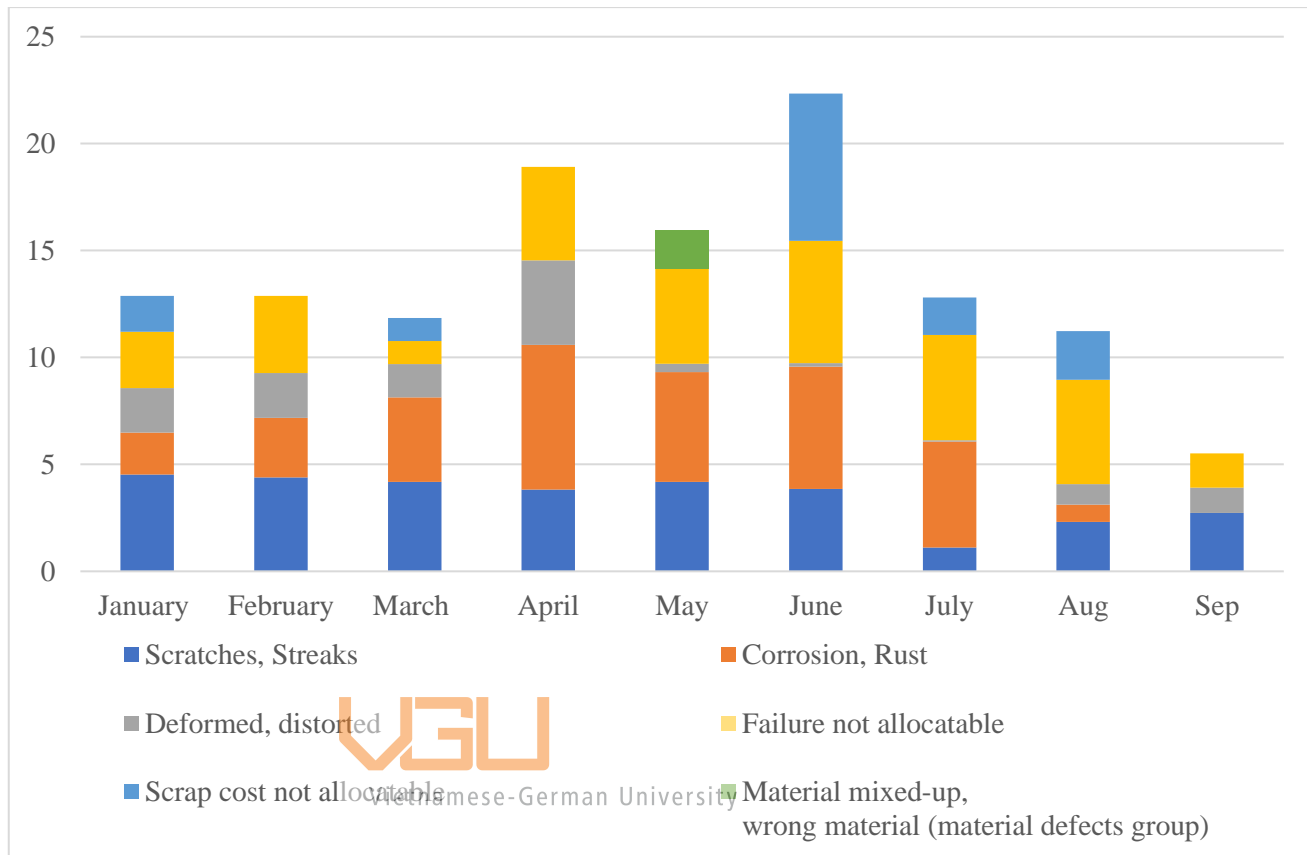


Figure 20. Column charts of failure cost of the defects over months

The column charts above show that the percentage only slightly lowered while applying the new digital tool manufacturing in August. But this amount was cut a half by the next month to 5.38 percent.

The dissertation will make some research methodologies such as interviews, surveys, and group discussions to clarify the advantages and disadvantages of the system. Continuous improvement is one of the most important in the manufacturing business.

1.4. Methodology

1.4.1. Research approach

It is critical to select the most appropriate technique for the research in order to obtain the most accurate results. There are three types of research approaches that are commonly used: qualitative, quantitative, and a combination of both qualitative and

quantitative methods (sometimes known as mixed methods). An investigation into the benefits of adopting a digital management system rather than paper in a bearing manufacturing company will be conducted in this thesis using a combination of qualitative and quantitative research methods.

a. Qualitative research method

Qualitative research is defined as “a strategy for examining and identifying the viewpoints of individuals or groups on a social or human topic,” according to the dictionary. As a general rule, this method collects non-numerical information from participants, and the results are delivered in the form of written descriptions, photographs, films, or audio recordings.

This technique is suited for exploratory research of a preliminary nature (e.g., during the pilot stage of a research project, for example). When confronted with an unforeseen event, the purpose of this strategy is to have a comprehensive understanding of the players involved.

b. Quantitative research method

In contrast to the qualitative research approach, the quantitative research method concentrates on collecting numerical and figure data in order to show the results in tables, graphs, and charts such as pie charts or Pareto charts as fast and efficiently as possible.

In the majority of circumstances, the quantitative technique is used to quantify attitudes, actions, and other specific factors in order to validate or refute the hypothesis of the project.

c. Mixed research method

It is true that mixed-method research is a blend of qualitative and quantitative approaches, as the name suggests. With the help of this method, we can summarize or investigate the advantages and disadvantages of an experiment in greater depth.

In light of the understudied phenomenon of digital tools in the context of a Vietnamese organization, an inductive technique is appropriate for the advancement of study. Specific numbers and experiences were created during the observation and testing processes, based on the inspections and pilot studies that were conducted.

In the dissertation, students will utilize a mixed research method to examine data collected over time through observation, doing several surveys in a bearing manufacturing facility. Following data collection, the student will take measures to illustrate the benefit gained from the digital system – CoSP (Control of Suspicious Parts).

1.4.2. An introduction to sampling methods

Once the research methods have been determined, the student can proceed to the next step in order to increase the efficiency of the dissertation by taking the following considerations. Aside from the study methodology, selecting a sample is one of the most important components of the research process. This is a wonderful strategy for spending less time and money while still creating a high-quality dissertation, and it should be considered by every researcher when conducting research or conducting a survey in the future. In terms of reducing the length of the survey while keeping high accuracy, the sampling method is highly effective.

a. Population versus sampling

It is tough to begin a survey on something to a group of people since it is difficult to collect data from every single person in that group. The most important reason why the student chooses the sampling strategy is that it allows him to use a small number of individuals and save time when calculating the advantage that the system has gained over the competition. A relatively small population can be classified in a variety of ways, including age, position, income, gender, and so on. The population can also be divided into subgroups.

Normally, the student must assign an equal chance of being picked to form a sample to each instance in the population he or she is studying. Because no cases have a zero chance of being selected to participate in the survey, a list of all possible instances drawn from the population is referred to as the ‘sampling frame.’

b. The size of the sample

The sample size that the student collects must be large enough to be employed in the creation of an analysis. The small size of the model can have a negative impact on valuable results since the individual may not return the surveys, or certain questions may be incomplete or incoherent due to the small size of the model. This can result in a

significant disparity in analytical data counts between genders, occupations, and other factors.

However, in order to determine whether or not the size is sufficient, pupils must employ a variety of ways. First and foremost, we must examine the amount of the affection for the survey that we are investigating. Generally speaking, in social science research, the influence of size is relatively minor and insignificant to consider. Finding good impacts in research about the effects of treatments by social workers, for example, can be difficult to come by in some cases. According to research, the level of promotion at a company and the increase in compensation are mostly determined by the professional capability and the ability to interact and adapt to the workplace, which account for around eighty to ninety percent of the total. The surroundings, management, and colleagues have barely a five to ten percent influence on one's behavior. As a result, the sample size must be large in order for the study to be able to determine the impact of the environment, the manager, and the colleges on an employee's promotion opportunity.

Then we must determine how many variables will be included in our investigations, the greater the number of variables, the larger the sample size. If we want to know the average height of the individuals in a group, for example, we can use the following formula: And they are all at the same height, allowing us to collect a single sample and receive an exact result very immediately after. However, when we consider the fact that the range in height between relatives is unusually great, we must measure multiple times to ensure accuracy.

c. Choosing the sample

There are two ways in order to choose the sample: probability sampling methods and non-probability methods

o Probability methods

It's the probability sampling method that's often utilized in quantitative approaches, and this is because it assures that every individual in a group is given the same chance of being selected to participate in the survey. When doing sociological research within a system that is chosen at random, this method provides the student with accurate results. Due to the fact that the data obtained through this method is easily visible in graphs and graphing tools, it is also often used for quantitative approaches.

- **Non-probability methods**

In contrast to the probability method, the non-probability approach involves the selection of persons based on criteria that are not determined by chance. This suggests that the individual who is chosen for the survey is doing so on purpose and that not everyone in the population has an equal opportunity of being selected. This type of methodology is typically employed in qualitative research and exploratory studies. This strategy aims to clarify, create an understanding, and stimulate the thinking of the individuals.

To summarize, the project's goal is to measure the level of satisfaction of end-users with the CoSP web-based system through a survey using a combination of probability and non-probability methodologies. The group interview between five Q-segment with the students is also being conducted in parallel with the survey to clarify the issues encountered while using a digital tool in production and constantly improve.

In conclusion, depending on the scope of the project, both qualitative and quantitative research methodologies could be employed in the dissertation in order to optimize the findings obtained from the research. By employing the mixed research approach, the student will be able to more thoroughly outline the two sides of advantages and negatives of the benefit that the web-based platform provides. It will be extremely difficult for the student to collect data from every single employee in the segment because the organization employs more than four hundred operators. By selecting the sampling method, this strategy enables the student to collect data from a survey on a small number of individuals and save a significant amount of time when identifying the benefit that the system has provided and also the remaining problems that the system has encountered in addition to the issues that have arisen during the system's development progress, among other benefits. In light of the study that the student conducted research on, as well as discussions with the company's experienced engineers during the development of the web-based system, the student has decided to randomly select ten operators with years of experience less than three years and another ten operators with years of experience greater than three years to participate in the survey. For starters, the student will use non-probability methods to distinguish between operators who have worked for more than three years and those who have worked for less than three years in the industry. In the following step, the student uses the

probability to select ten operators from each group at random to participate in the survey. In order to conduct qualitative research, the student will request the Q-segment to participate in a group interview in order to gain a more in-depth understanding of the advantage obtained and the areas that require improvement. Those steps will be discussed specifically in the following chapter.

2. Do

2.1. Choosing the sample

Table 2. List of operators has less than three years of experience

No.	Name	Gender	Nationality	Position	Years in Field
1	Nguyen, Bao Loc	Male	Vietnam	Operator	2 years
2	Cao, Quoc Cuong	Male	Vietnam	Operator	1 year
3	Tran, Thanh Tin	Male	Vietnam	Operator	2 years
4	Nguyen, Viet Long	Male	Vietnam	Operator	1 year
5	Nguyen, Quang Trung	Male	Vietnam	Operator	2 years
6	Le, Dang Anh Dien	Male	Vietnam	Operator	2 years
7	Dang, Thanh Long	Male	Vietnam	Operator	2 years
8	Doan, Van Canh	Male	Vietnam	Operator	2 years
9	Nguyen, Duy Tuan	Male	Vietnam	Operator	1 year
10	Nguyen, Ngoc Nga	Female	Vietnam	Operator	2 years



Table 3. List of operators has more than three years of experience

No.	Name	Gender	Nationality	Position	Years in Field
1	Dinh, Thi My Ngan	Female	Vietnam	Operator	3 years
2	Tao, Duy Bao	Male	Vietnam	Operator	4 years
3	Nguyen, Trong Tin	Male	Vietnam	Operator	5 years
4	Dao, Thanh Nguyen	Male	Vietnam	Operator	3 years
5	Nguyen, Van Thang	Male	Vietnam	Operator	3 years
6	Huynh, Minh Phu	Male	Vietnam	Operator	3 years
7	Do, Quang Vinh	Male	Vietnam	Operator	4 years
8	Nguyen, Tuyet Nhung	Female	Vietnam	Operator	3 year
9	Bui, Ngoc Huong	Female	Vietnam	Operator	3 year
10	Bui, The Long	Male	Vietnam	Operator	4 years

The list of end-users can be seen in the table above. The two tables above provide the information about the operator who will enter the data into the web-based system. First, the student utilizes the non-probability approach to partition the complete population of four hundred operators into two groups with qualities that correlate to the year of

experience. One group consists of individuals with fewer than three years of experience. And the other one includes the person with three years or more of experience working in the operator function. Then the learner continues to utilize the probability method to select the population in two groups randomly. The student will choose ten individuals to take the survey in each group. The operator was determined randomly by utilizing a random number generator tool (<https://www.random.org/>). The number of operators which has been chosen from the population accounts for five percent of the overall population. The student is able to determine the value of the web-based system by dividing the group of operators into groups based on their level of knowledge and expertise. The most significant difference between junior operators and experienced operators is their skill in manipulation, as well as their level of knowledge of the necessity of downtime reduction and reduced effort on the part of the person who has worked for a long time.

Table 4. List of Q-segment participate in the group interview

No.	Name	Gender	Nationality	Position	Years in Field
1	Bui, Cong Thuc	Male	Vietnam	Q-segment	5 years
2	Tran, Quang Quy	Male	Vietnam	Q-segment	2 years
3	Tran, Van Xuan	Male	Vietnam	Q-segment	6 years
4	Ngo, Thi Tho	Female	Vietnam	Q-segment	3 year
5	Le, Xuan Tha	Male	Vietnam	Q-segment	4 years

Table 4 provides the information about the list of persons who will get the reported data and assign tasks or make decisions when the operator adds the info. In the list below, all five individuals will be requested to participate in a group interview to discuss the advantages and the obstacles when applying the CoSP in operation. People in the list below are experts in the manufacturing area with many experiences and knowledge. By discussing in a group of six (including the learner), each member is able to share their opinion, edges of concerns about the web-based system. This type of technique provides the student with superior observation perspectives rather than a face-to-face interview of each person. Because in the face-to-face interview, since the student only join the project as the supporter, not the end-user who mainly uses the system, so that the

questions that the author asks might not be objective as well as intuitive enough to be able to clarify the issues that occur while using the system.

2.2. Survey

2.2.1. Design the survey

In this stage, the student creates the survey to clarify if the system works well to support the operator to handle the suspicious parts; if the system reduces their workload as expectation or not; is there any concern, issue while using the system; is the system work good enough or still be lag or delaying; etc. The student will collect data for analysis and use it to examine in the CHECK section of the thesis through the survey.

In order to acquire the best result from the survey, in the first phase, the student must read through the scope of the project in the project charter to assess which question should be asked to identify the performance of the applied system.

Table 5. Table of checklist needed information for the survey


Objectives	Needed information	Question
<p>Reduce the workload of the operator by applying the web-based system.</p>	<p>_How does the system affect the workload of the operator?</p> <p>_How is the time input information on the paper compared with the time input information in the system?</p> <p>_Does the efficiency of communication between operators with Q-segment be improved? How does it improve? (More effective/ Unchanged/ Less effective)</p>	<p>_From 1-10 on the scale (10: very good, 5: neutral, 1: very bad), how is your satisfaction with the web-based system?</p> <p>_ From 1-10 on the scale (10: Effectively, 5: neutral, 1: Useless), how does the system affect your communication between you and the Q-segment?</p> <p>_How long does the old method take you to input fully the information? (Using paper to control suspicious part/ Input all the suspicious parts of Production Orders of the shift)</p> <ul style="list-style-type: none"> ○ Less than 10 minutes ○ 10 – 20 minutes ○ More than 20 minutes <p>_How long does the web-based method take you to input fully the information? (Input all the suspicious parts of</p>

		<p>Production Orders of the shift)</p> <ul style="list-style-type: none"> ○ Less than 10 minutes ○ 10 – 20 minutes ○ More than 20 minutes <p>_From 1-10 on the scale (10: Reduce very much, 5: neutral, 1: Increase very much), how does the CoSP affect your workload?</p>
<p>Use the system as a quick response quality control in the process to eliminate failures.</p>	<p>_What is the experience of the end-user about the system?</p> <p>_How does the system affect the time of solving the suspicious parts? (Faster/ Lower/ Unchanged)</p> <p>_How do the failures change when applying the tools into production? (Increase/ Decrease/ Unchanged)</p>	<p>_Does the system support you well to have a good action plan whenever the issue happens? (Yes/ No)</p> <p>_How long does the old system take time to solve suspicious parts?</p> <ul style="list-style-type: none"> ○ Less than 24 hours ○ One day to 20 days ○ More than 20 days <p>_How long does the CoSP system take time to solve suspicious parts?</p>

		<ul style="list-style-type: none"> ○ Less than 24 hours ○ One day to 20 days ○ More than 20 days <p>_From 1-10 in the scale (10: decrease, 5: neutral, 1: increase), how do the failures change when applying the new tools into production?</p>
<p>Reduce downtime of solving suspicious parts.</p>	<p>_ How the system effect to the time of solving the suspicious parts? (Faster/ Lower/ Unchanged)</p>	<p>_How long does the old system take time to solve suspicious parts?</p> <ul style="list-style-type: none"> ○ Less than 24 hours ○ One day to 20 days ○ More than 20 days <p>_How long does the CoSP system take time to solve suspicious parts?</p> <ul style="list-style-type: none"> ○ Less than 24 hours ○ One day to 20 days ○ More than 20 days



<p>Increase the data transparency.</p>	<p>_Does the data be published? _How does the data's transparency change? (Increase/ Decrease/ Unchanged)</p>	<p>_From 1 – 10 (10: increase, 5: neutral, 1: decrease), how does the data's transparency change? _From 1 – 10 (10: Very easy, 5: Neutral, 1: Very hard) Does the data easy to access to everyone?</p>
<p>Increase the effectiveness of handling suspected parts => clear WIP in stock.</p>	<p>_How the effectiveness of handling suspected parts change? (Increase/ Decrease/ Unchanged) _How does the failure cost that caused by stack parts in stored area change? (Increase/ Decrease/ Unchanged)</p>	<p>_Do the suspicious parts in the stock area when using the CoSP reduce compared with the paper? <ul style="list-style-type: none"> o Reduce o Unchanged o Increase _ How does the failure cost caused by stack parts in stored area change? <ul style="list-style-type: none"> o Decrease o Unchanged o Increased </p>
<p>Improve the end-user satisfaction when applying the digital tool to production.</p>	<p>_How is the satisfaction of the end-user about the system? (Very bad/ Bad/ Neutral/ Good/ Very good) _Which causes the bad experience of the end-user when using the system? (Describe detail) => ask specific into separate parts of the system to clarify.</p>	<p>_From 1-10 on the scale (10: Very good, 5: Neutral, 1: Very bad), how is your satisfaction with the web-based system? _From 1-10 (10: Very easy, 5: Neutral, 1: Very difficult), how is your</p>

	 <p>Vietnamese-German University</p>	<p>satisfaction with the login template? If there is any concern, please input your opinion below.</p> <p>_ From 1-10 ((10: Very easy, 5: Neutral, 1: Very difficult), how is your satisfaction with the input information template? If there is any concern, please input your opinion below.</p> <p>_ From 1-10 ((10: Very good, 5: Neutral, 1: Very difficult), how is your satisfaction with the template of the issues list? (does it visualize enough, does it hard to understand)</p> <p>_ From 1-10 ((10: Very easy, 5: Neutral, 1: Very difficult), does the template of the exported data fulfilled information for you? If there is any information you need to input into the template, please input it below.</p> <p>_ From 1-10 ((10: Very easy, 5: Neutral, 1: Very difficult), Is it easier for you to receive the task to</p>
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		<p>define the issues of the suspicious parts from the Q-segment when using the automation email of the CoSP?</p> <p>_ From 1-10 ((10: Very good, 5: Neutral, 1: Very bad) Does using the CoSP help you work more effectively than using paper to control suspected parts?</p>
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2.2.2. List of question

i. Personal Information

1. Your ID
2. Your gender
3. Years in the field



ii. Efficiency

4. From 1 – 10 (10: Increase, 5: Neutral, 1: Decrease), how does the data's transparency change?
5. From 1-10 on the scale (10: Effectively, 5: neutral, 1: Useless), how does the system affect your communication between you and the Q-segment?
6. From 1-10 on the scale (10: Reduce very much, 5: neutral, 1: Increase very much), how does the CoSP affect your workload?
7. From 1-10 on the scale (10: Decrease, 5: Neutral, 1: Increase), how do the failures change when applying the new tools into production?
8. From 1-10 on the scale (10: Effectively, 5: neutral, 1: Useless), how does the system support you to have a good action plan whenever the issue happens?
9. How long does the web-based method take you to input the information fully?
(Input all the suspicious parts of Production Orders of the shift)
 - Less than 10 minutes
 - 10 – 20 minutes

- More than 20 minutes
10. How long does the old system take time to solve suspicious parts?
- Less than 24 hours
 - One day to 20 days
 - More than 20 days
11. How long does the CoSP system take time to solve suspicious parts?
- Less than 24 hours
 - One day to 20 days
 - More than 20 days
12. How long does the old system take time to solve suspicious parts?
- Less than 24 hours
 - One day to 20 days
 - More than 20 days
13. How long does the CoSP system take time to solve suspicious parts?
- Less than 24 hours
 - One day to 20 days
 - More than 20 days
14. Do the suspicious parts in the stock area when using the CoSP reduce compared with when using the paper?
- Reduce
 - Unchanged
 - Increase
15. How does the failure cost that caused by stack parts in stored area change?
- Decrease
 - Unchanged
 - Increased

iii. **Satisfaction**

16. From 1-10 on the scale (10: Very good, 5: Neutral, 1: Very bad), how is your satisfaction with the web-based system?
17. From 1-10 (10: Very easy, 5: Neutral, 1: Very difficult), how is your satisfaction with the login template? If there is any concern, please input your opinion below.

18. From 1-10 ((10: Very easy, 5: Neutral, 1: Very difficult), how is your satisfaction with the input information template? If there is any concern, please input your opinion below.
19. From 1-10 ((10: Very good, 5: Neutral, 1: Very difficult), how is your satisfaction with the template of the issues list? (does it visualize enough, does it hard to understand)
20. From 1-10 ((10: Good, 5: Neutral, 1: Not enough), does the template of the exported data fulfilled information for you? If there is any information you need to input into the template, please input it below.
21. From 1-10 ((10: Very easy, 5: Neutral, 1: Very difficult), Is it easier for you to receive tasks to define the issues of the suspicious parts from the Q-segment when using the automation email of the CoSP?
22. From 1-10 ((10: Very good, 5: Neutral, 1: Very bad) Does using the CoSP help you work more effectively than using paper to control suspected parts?
23. If there is any concern, please input your opinion.

2.3. Group interview

In this stage, the student will join in a group discussion with the attendance of five Q-segment who are experienced engineer to have a short conversation about the benefit that the CoSP system bring, also the challenges while using it, and the downsides of the system. Q-segment is the person who is accountable for the quality of the product in lines. Their tasks are evaluating, upgrading, and maintaining the system, and the leading player for quality assurance in the manufacturing line to reach zero consumers complain. In the Schaeffler corporation, there are three segments. Mr. Bui Cong Thuc and Mr. Tran Quang Quy are accountable for the product in Segment 01. Mr. Kisa Marian and Mrs. Ngo Thi Tho handle Segment 02. And Segment 03 is answerable for Mr. Le Xuan Tha. All of them are long-term engineers with vast experience in producing quality, quality planning, and quality system, and customer complaint management. In their job, they will receive information about the issue through emails whenever the operators submit the report. And they are the one who will decide to assign tasks or not to verify the core cause of the problems, then make the decision.

Table 6. List of Q-segment

No.	Name	Gender	Nationality	Position	Years in Field
1	Bui, Cong Thuc	Male	Vietnam	Q-segment 01	5 years
2	Tran, Quang Quy	Male	Vietnam	Q-segment 01	2 years
3	Tran, Van Xuan	Male	Vietnam	Q-segment 02	6 years
4	Ngo, Thi Tho	Female	Vietnam	Q-segment 02	3 year
5	Le, Xuan Tha	Male	Vietnam	Q-segment 03	4 years

In the interview, the students will start with a quick introduction of the web-based system since it was being piloted for a short duration of period. Then to continue the discussion, the student asks five individuals to offer their perspective about the CoSP and argue and discuss with each other. The author joins in the meeting to explain more if there is any worry from them and gather information of the advantages of the system to continuous improvement. Besides, if there are any challenges, the student notes their opinion to solve, improve, or put in more functionalities to help decreasing the end-user's time of operation. Due to the workload of the segment, only one Q-segment from each segment join in the meeting, which is Mr. Bui Cong Thuc from Segment 01; Mr. Nguyen Kim Thanh Phuc from segment 02; Mr. Le Xuan Tha from segment 03.

3. Check

3.1. The survey

In this phase of the dissertation, the results of the survey and group discussion will be discussed in greater detail. Based on their evaluation and action plan for further progress, the students will concentrate efforts on the category that received a score lower than eighty percent.

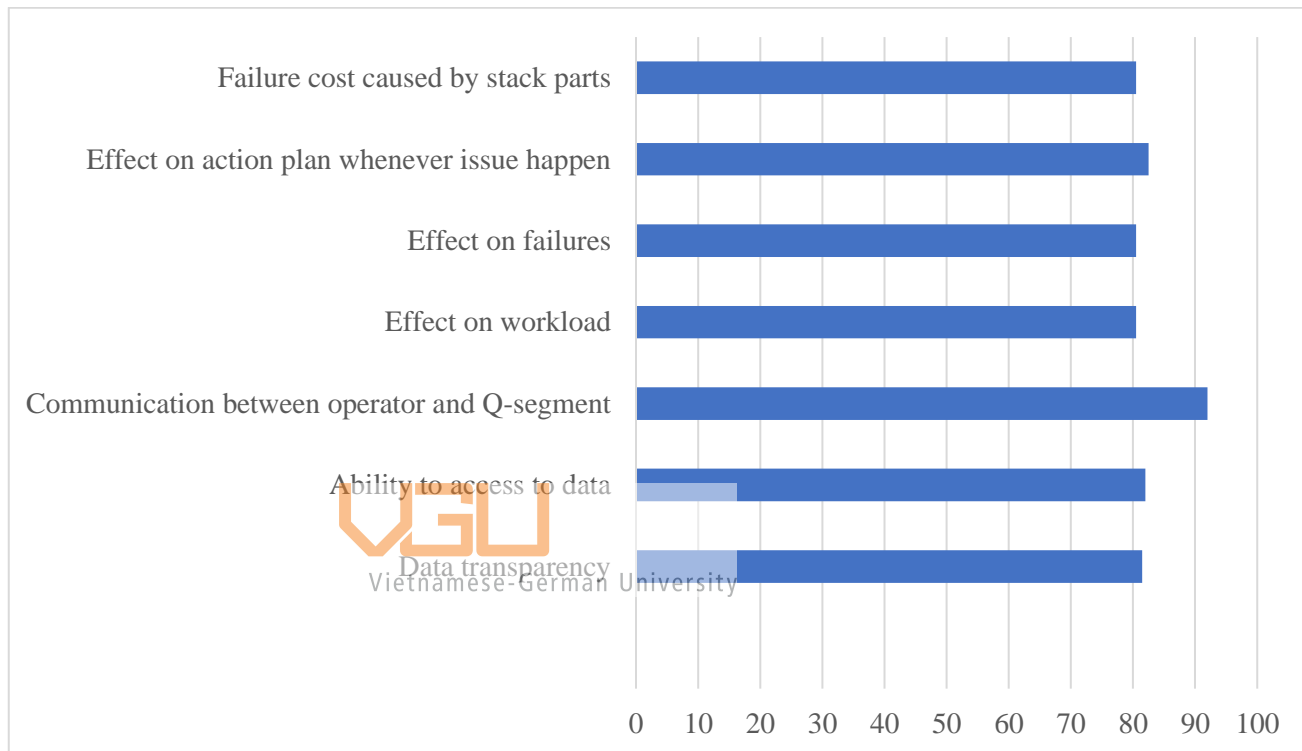


Figure 21. Chart of the point in percentage of efficiency achieved from the survey

In general, the web-based system's efficiency scores are quite high, and this is reflected in the results. The defect's failure cost has also been demonstrated the efficiency of the system in the bar chart below. The failure cost has fallen slightly in the first month of piloting in August, not much, but there has been a small step forward in terms of progress. The failure cost decreased significantly in the following month, accounting for only 5.38 percent of total failure costs in this month. In order to maximize efficiency, the student continues to track the failure cost over the course of the following months in order to make continual improvements.

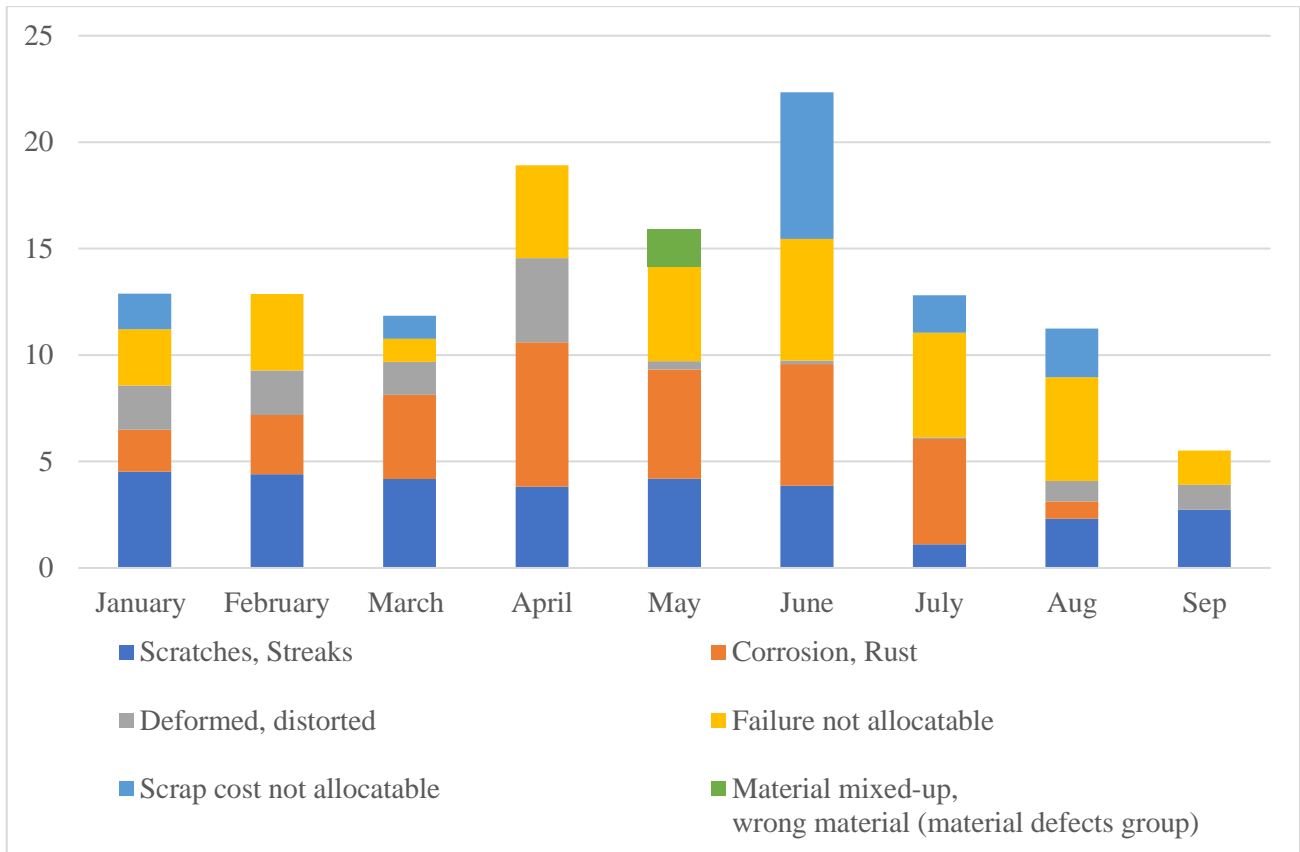


Figure 22. Column charts show the frequency of the percentage of the failure cost

The findings of the satisfaction evaluation are largely favorable, with the exception of the two categories that score lower than the minimum criteria, particularly the capacity to perform the receiving task (16.5 percent). Furthermore, the quality of the input information template that was received the point was poor (69 percent). It is simple to observe from the results that the ability to receive tasks for operators was extremely challenging. The key factor influencing the ability to receive tasks is the fact that only Q-segment employees and inspectors have laptop computers for work, which allows them to get emails from the system with ease. Operators who are primarily responsible for completing works, such as re-measuring parts or taking photographs of parts, are only allowed to receive assignments through email if they have access to the computer at the CoSP station and have logged into their account with the CoSP system. If this is not the case, they will not be notified of the task on the system. That is the primary reason why the operators provide such a low score to the player in question. This was a significant difficulty because, when the system was established, the project's goal was to make it easier for the operators to get their tasks. However, in this instance, the

operators must spend time logging into the system in order to check for jobs that have been assigned to them.

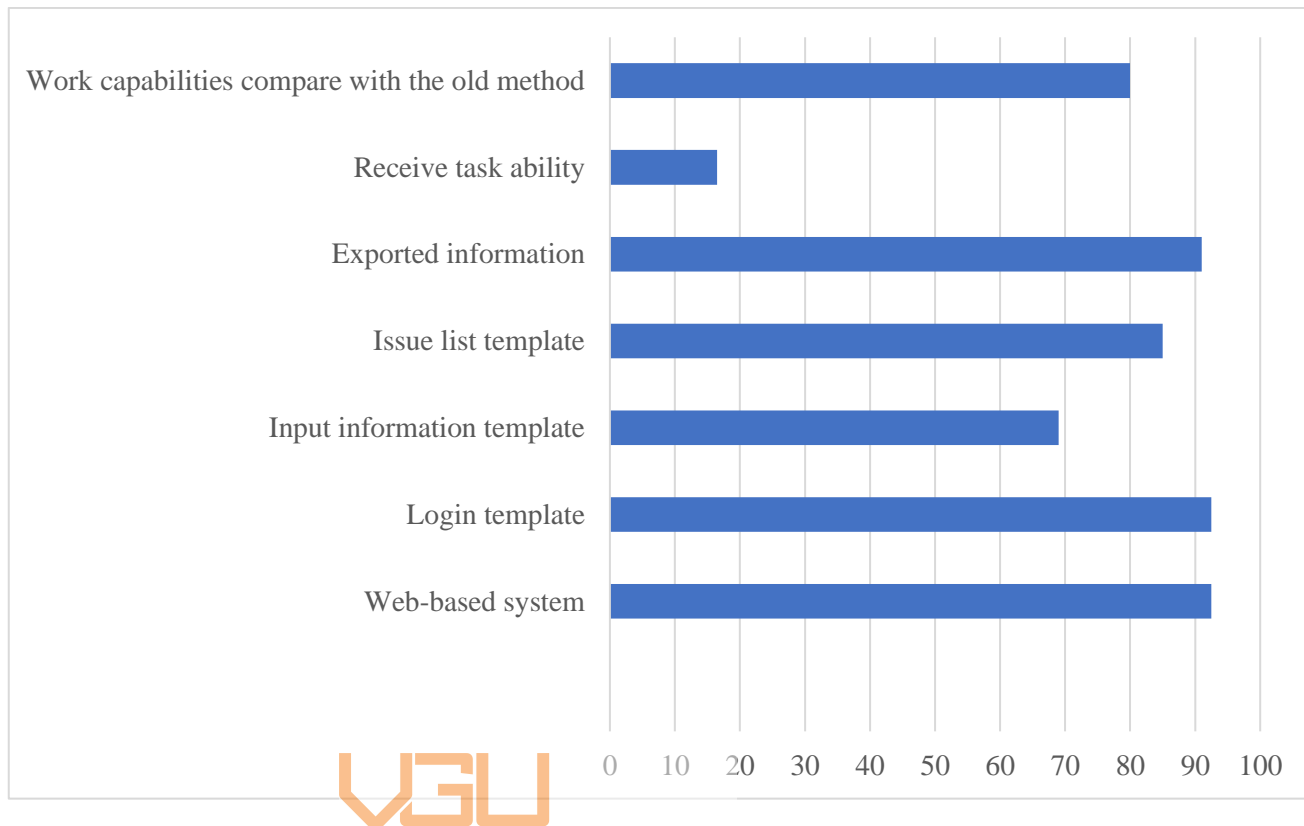


Figure 23. Chart of the point in percentage of satisfaction achieved from the survey

Furthermore, the input information template earns a poor rating (only 69 percent) from the operators, though not as terrible as the capacity to perform the received duty. Many operators who took part in the study stated that they found it difficult to enter the information about the defect code, which they believe is the fundamental problem. It was claimed that it was difficult to recall because the list of codes was lengthy and that they only remembered the codes that were regularly used.

In general, there are two areas for which the student must produce solutions in order to increase the quality of the system: receive task ability and input information template, both of which are listed below. After that, keep an eye on the system to ensure that the greatest possible outcome is achieved.

3.2. Group interview

For the group discussion between the student and three Q-segment. The received results were quite good, All three Q-segment agree that the system has a good effect on solving the suspicious parts. In general, the project's efficiency goal has been met in terms of

overall performance. Failures have decreased since the system was piloted in the plant, which is consistent with the data obtained from the failure cost report produced in August and September. Three Q-segment confirmed that failures have decreased since the system was piloted in the plant.

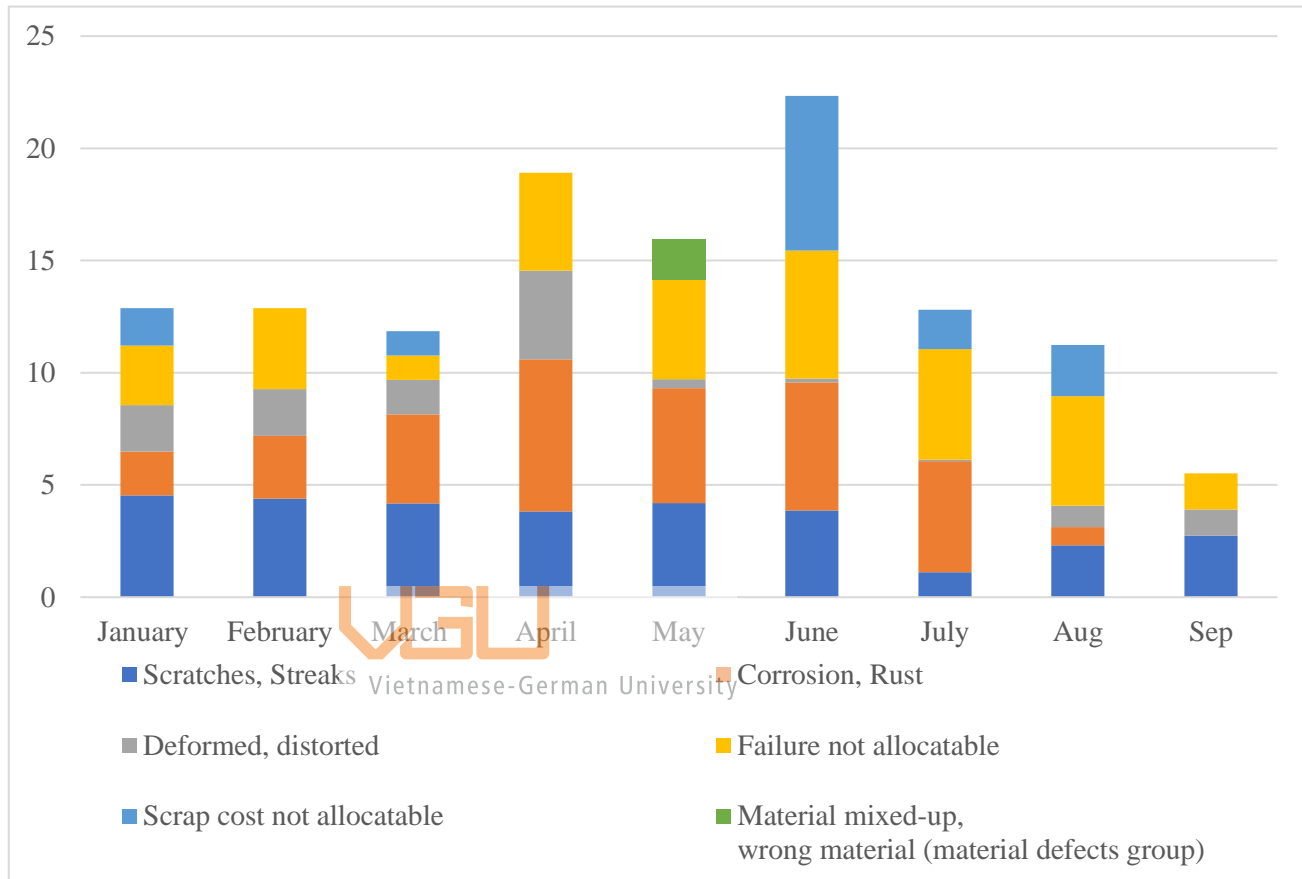


Figure 24. Column charts show the frequency of the percentage of the failure cost

According to the three Q-segments, the project has been completed to the satisfaction of all parties involved. However, some of the feedback has to be refined even more. The first is that the operator is unfamiliar with utilizing a web-based system because he has only just become acquainted with this type of technology. For certain operators, this results in a variety of difficulties. In some cases, they took too long to complete the information entry process, or they entered incorrect information into the report, which had a direct impact on the exported data.

To address this type of issue from one of three Q-segments, the proposed response plan is to conduct more training courses to ensure that the operators become familiar with using the computer at the outset, followed by training on how to operate the system

efficiently in the long run. Furthermore, the operators find it difficult to recall all of the defect codes that are stored on the system. When dealing with this type of problem, there are two actions to take. The first step is to construct a suggestion menu list, which will make it easier for the operators to enter information into the information box whenever they need to. The next step is to print off the work instruction that will be used in conjunction with the training sessions and attach it to the CoSP station. Attaching the WI immediately next to the CoSP station will reduce the proportion of time that the operators are unsure of what needs to be entered into the system. The correctness of the data exported from the system will be improved as a result of this. In addition to the training sessions, Mr. Bui Cong Thuc has come up with the idea of printing out the defect codes and attaching them with the work instructions so that operators can look for the defect codes whenever an unfamiliar problem occurs in the plant.

4. Act

The advantages	The remaining problems	Potential solution
_Reduce the workload of the operator by applying the web-based system.	_Continue monitoring for improvement.	N/A
_Use the system as a quick response quality control in the process to eliminate failures.	_Operators need to access to the computer at CoSP station and log in to receive task, otherwise they will not be notified of the task. => Lack of efficiency. => Receive task ability goal not achieved.	Option 1: Create group of operators following each segment on the system. Whenever the task was assigned by the Q-segment, the task will be notified on the computer screen as a message notification. Option 2: After the Q-segment assign tasks on the system, the system will automatically send a message to private phone of the assigned operator.
_Reduce downtime of solving suspicious parts.	_Continue monitoring for improvement.	N/A
_Increase the data transparency.	_Continue monitoring for improvement.	N/A
_Increase the effectiveness of handling suspected parts => clear WIP in stock area.	_There are still exist failure cost due to stack part in stock area.	_Print out paper of the defect code list and attach it right next to the CoSP station. _Construct a suggestion menu list, which will make it easier for the operators to enter information into the information box.

	<p>_The operator is unfamiliar with utilizing a web-based system.</p>	<p>_Conduct more training courses to ensure that the operators become familiar with using the computer at the outset, followed by training on how to operate the system efficiently in the long run _Print out the work instruction that will be used in conjunction with the training sessions and attach it to the CoSP station.</p>
	<p>_Q-segment 02 commented that currently, every time he wants to update the data on his computer, the system export data into a new excel file, and he need to copy the data from that file into his excel file. => Inconvenience. => Waste of time.</p>	<p>_Develop solution while exporting the data, Q-segment able to choose which columns, rows he wants to export, export to which file he want to.</p>

Table 7. Summarize the advantages, the remaining problems, potential solutions collected through surveys.

After being put into production, the system's performance was fairly good; however, the student must continue to monitor and gather data in order to make continual improvements. It has been possible to achieve the majority of the project's objectives. It has been decided to employ the web-based system as a quick reaction quality control in the process in order to eliminate failures. According to the results of the poll, eighty percent of the respondents believe that the CoSP has a good impact on the action plan when challenges arise during the process. The downtime associated with investigating suspicious parts has been minimized as a result of improved communication between operators, and the Q-segment has been enhanced. Due to the heavy workload of the Q-segment and its operators, they did not have much time to communicate, and the components were stacked higher and higher, eventually leading to scrapping in the previous process. Therefore, after implementing this digital tool, the failure cost of parts

caused by stack components in the stock area was modestly decreased during the piloting period and dramatically reduced during the following month, falling to 5.38 percent in September. In addition, the data transparency and other categories, as depicted in the two figures below, have been improved as a result of the survey results.

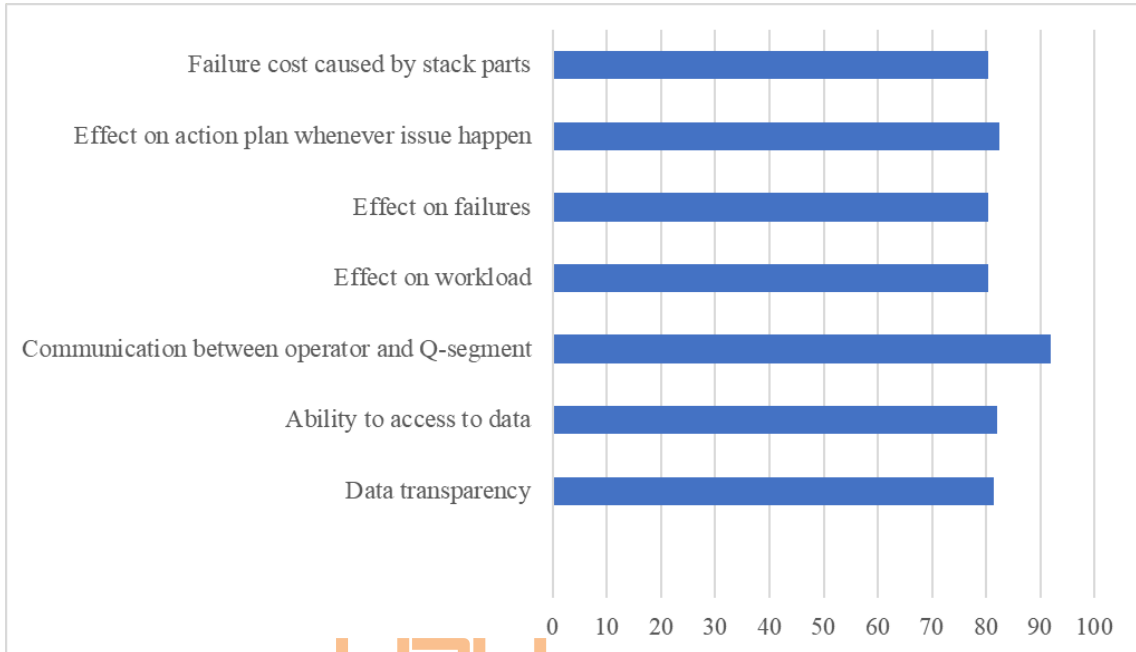


Figure 25. Chart of the point in percentage of efficiency of CoSP system achieved

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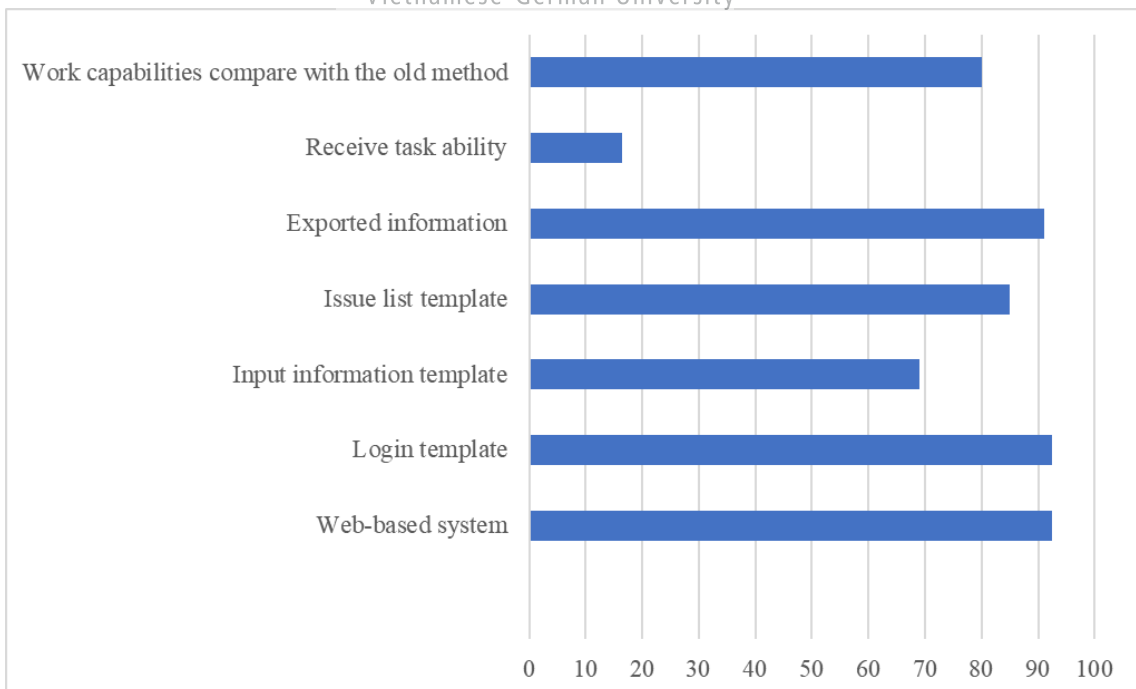


Figure 26. Chart of the point in percentage of satisfaction of operators achieved

However, during the development stage, there are always new issues that surface that need to be addressed. Despite the fact that the system has been employed as a quick

reaction tool to eliminate problems, the operators discovered that this category did not accomplish the system's aim. The reason for this is that anytime the Q-segment distributes tasks to system operators, they must access the computer at the CoSP station and log in to the system in order to receive duties; otherwise, they will not be notified. However, because they were not informed of the task, they continued to carry out their duties without being aware of the suspicious elements. As a result, the downtime associated with resolving suspect portions is prolonged until operators get access to the system. The tool's goal is to fix the pieces as quickly as possible, which is why there are still a number of parts that are scratched or bent after all this time. The student has two options for dealing with this type of problem. The first step is to form three groups of operators, one for each element of the system that has been established. The task will be alerted on the computer screen as a message notification whenever the Q-segment assigns it to the user. Several issues will occur as a result of this idea, according to student opinion. In the first place, there is a waste of electrical power. It is necessary for the computer to remain operational 24 hours a day, seven days a week in order to send message notifications. This will result in a significant waste of electrical resources. Furthermore, the computer's life expectancy will be reduced after a certain amount of time. It is possible that the computer at the CoSP station will need to be updated or replaced after only a short period of time. In this case, the student chooses the second option: once the Q-segment provides tasks to the system, the system will send an automated message to the private phone of the operator who has been allocated the tasks. Because everyone has their own personal telephone, it appears that this option is more feasible than the first. The difficulty in implementing this option is in developing an automated system to send messages to a personal cellphone through a web-based system. In order to complete the work, the student will require more time to debate his or her ideas with experienced engineers in order to refine them. However, due to the time constraints of the dissertation, the student is only able to provide proposals for solutions to this challenge.

However, when attempting to design a web-based system, the pleasure of end-users should always be regarded as one of the most crucial considerations to make. The second issue that occurs is the "Input information template." This is described below. The feedback from the operators indicated that they had trouble inputting the information regarding the defect code, which may explain the low score of the input

information (which accounts for just sixty-nine percent of the total). They complained that the defect code lists were too large and that it was difficult for them to recall all of the faults' codes. Following a discussion with the Q-segments, prospective remedies for this issue are divided into two categories. To complete the temporary action, the student will print out all of the defect codes found across the facility and attach them directly to the CSP station's control panel. It is designed in such a way that, while operators are entering the defect's details, they may also identify the precise code associated with the problem. The student's proposal for the long-term action is to compile a list of suggestions, which he believes will be useful. Following the selection of the defect code box by the operators, the proposed list will appear immediately below the box, and the operator can also discover the defect code by searching for the defects' character descriptions in the suggested list. When compared to the short-term action, the time required to enter the information will be reduced slightly more by incorporating this feature. Additionally, the effort of the operators will be reduced because they will no longer be required to recall the fault code. It is possible to look for the fault code depending on the description of the characteristic. With regard to the short-term action plan, the student can put it into action immediately. However, in order to take a long-term action, the student must spend time speaking with the software engineer how to implement this feature in the near future.

After two months of piloting the system, the third point of worry is that the operator is unfamiliar with the concept of using a web-based system. According to the student's point of view, the underlying cause of this difficulty is tied to the earlier training sessions that were attended. Several possible solutions for this issue can be broken down into two steps. First, the student must identify the discrepancy between the previous training plan and the current one, as well as the reasons why the operators are still unable to utilize the system properly after attending the sessions. A new training class is created and a test is administered to determine the overall quality of the training sessions after the student has identified the gaps in the prior training courses. In addition, at the advice of Mr. Bui Cong Thuc, the student will print out the WI (work instruction) for the CSP system, which will be used in the classroom. Following the use of the two procedures described above, the student continues to monitor and evaluate the outcome that has been obtained over a period of time.

And, finally, according to Mr. Tran Van Xuan's input, he presently has to go to the website and export the data every time he wants to change the data he has already exported. However, because the exported data will be exported to a completely new excel file, he will need to duplicate the data from that file into the old file that he had previously exported in order to make it work. This issue will result in the Q-segment having to duplicate their work because the system will automatically export all of the columns and rows on the system, and the Q-segment will have to copy specific the column or row in which they require data to the previous file for easy tracking, which will result in the Q-segment having to duplicate their work. As a result, the proposal is to consult with the developer engineer in order to devise a method by which the system will automatically export the data to a specific excel file and also update the excel file after a period of time, thereby eliminating the need for the Q-segment to log into the web-based system every day in order to retrieve the data. By establishing this functionality, the Q-segment will no longer be required to manually update the data, resulting in significant time savings.

III. CONCLUSION

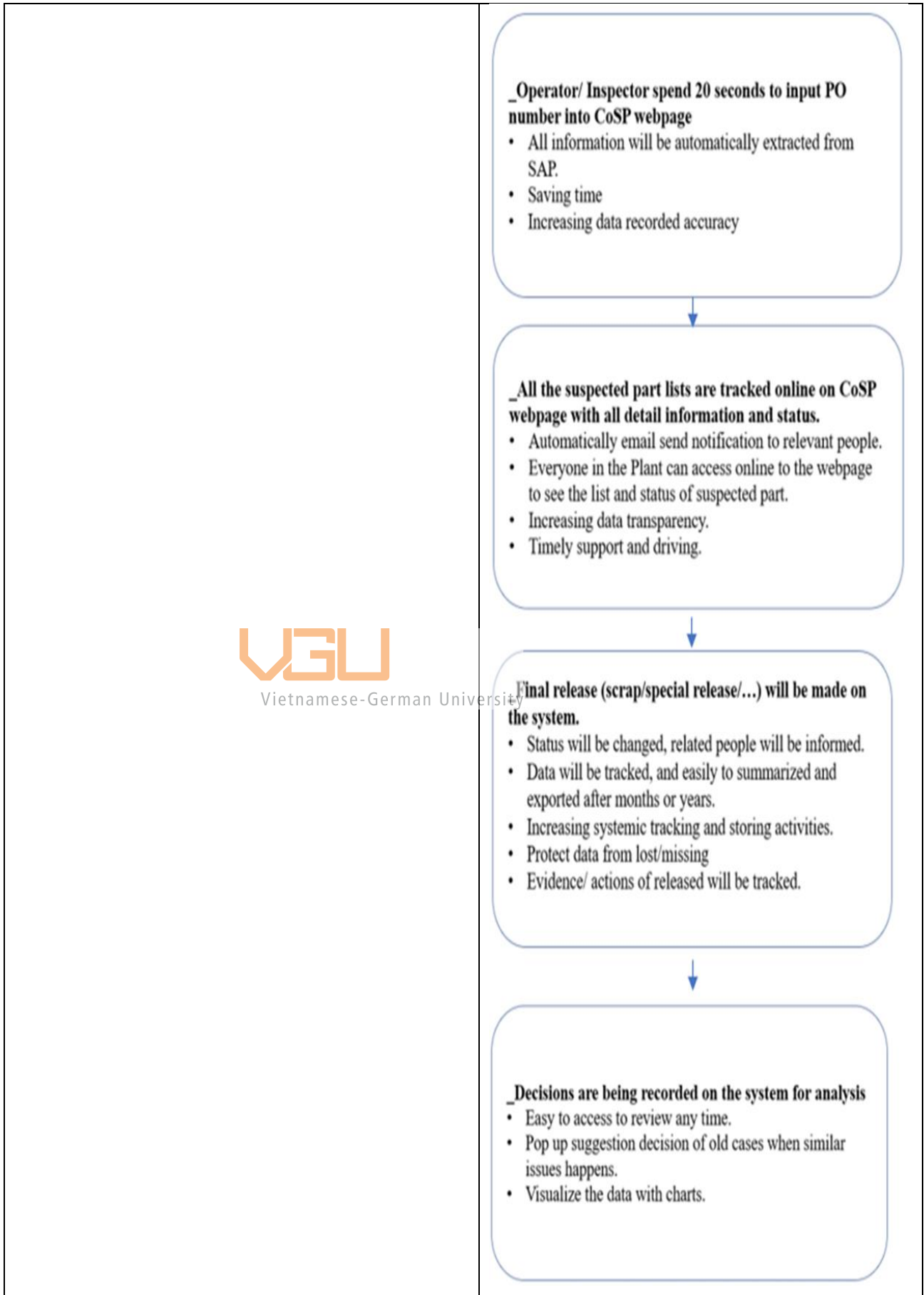
APPLYING PDCA CYCLE IN EFFICIENCY IMPROVEMENT FOR CONTROL OF SUSPICIOUS PARTS

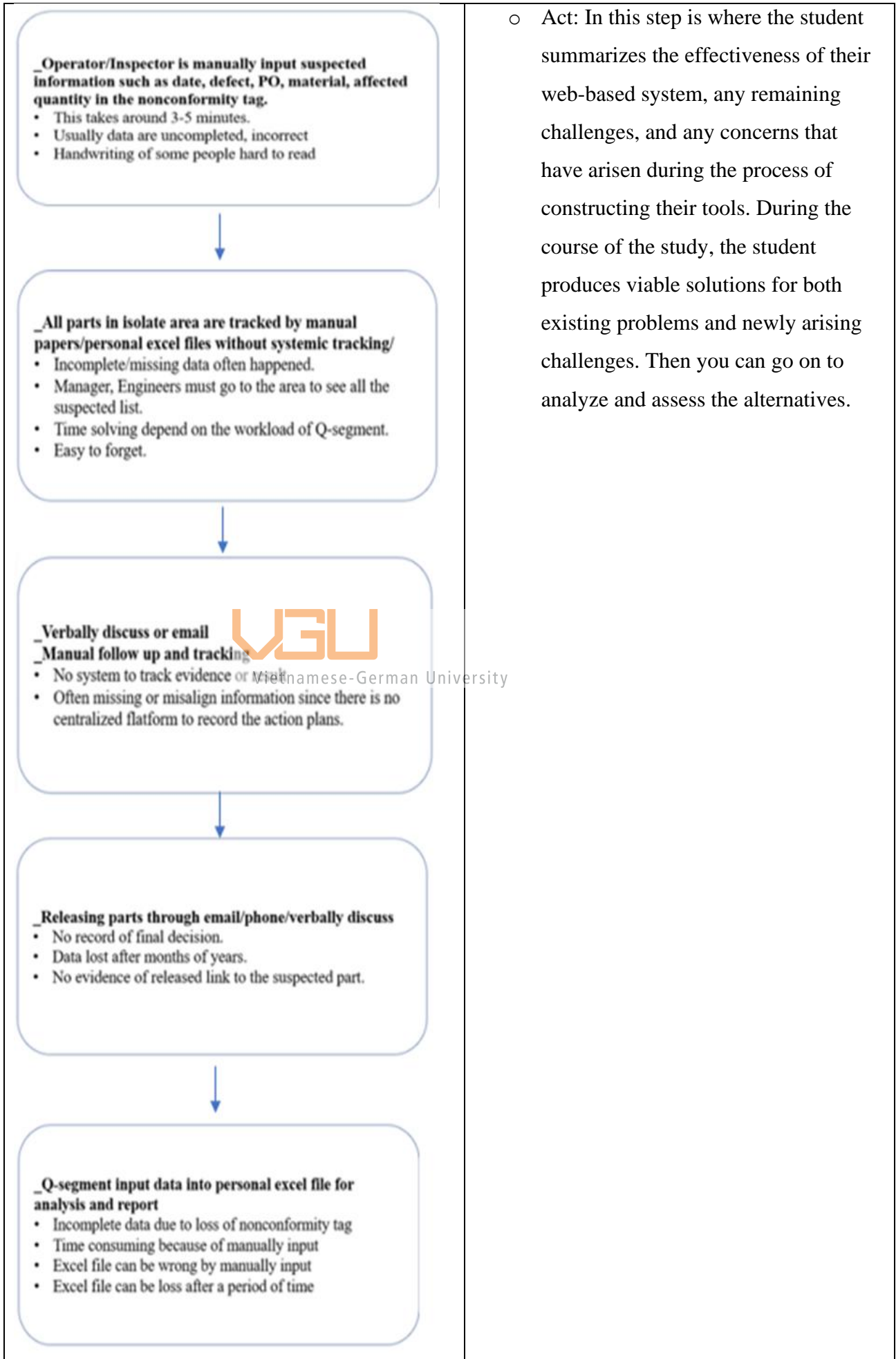
Background:

It is used in a bearing manufacturing company to follow the progress of control over suspicious parts, which is done on paper and by manual control. As a result, pieces that have the potential to be reworked are scraped, deformed, and otherwise damaged, and eventually become scrap parts. Each month, the failure cost of those components contributes for at least 10 percent of the total cost. Controlling and improving the efficiency of a web-based system that was being built to improve the control process for suspicious parts was accomplished through the application of the PDCA cycle.

Recommendations:

_Creating a web-based system to record data/ communication tool between operators and managers/ reduce the workload of operators/etc.





○ Act: In this step is where the student summarizes the effectiveness of their web-based system, any remaining challenges, and any concerns that have arisen during the process of constructing their tools. During the course of the study, the student produces viable solutions for both existing problems and newly arising challenges. Then you can go on to analyze and assess the alternatives.

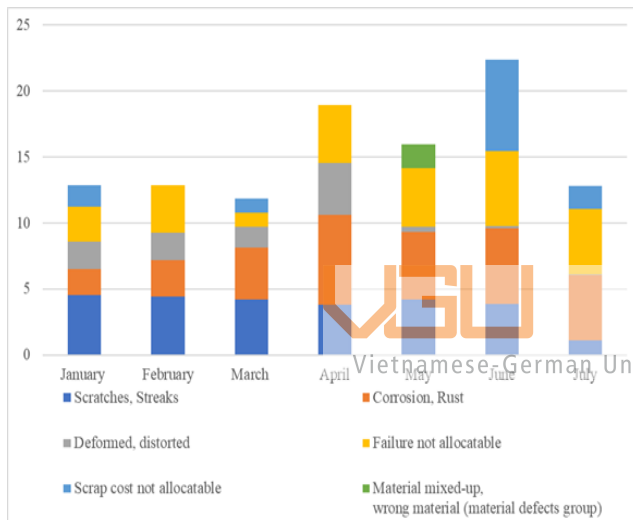
_Current time of solving of suspicious parts can be delay more than thirty days => parts being stacked in stock area => scratch, bend, etc. => scrapped => increase failure costs

_Using paperwork to track scrap parts => No data connection to SAP

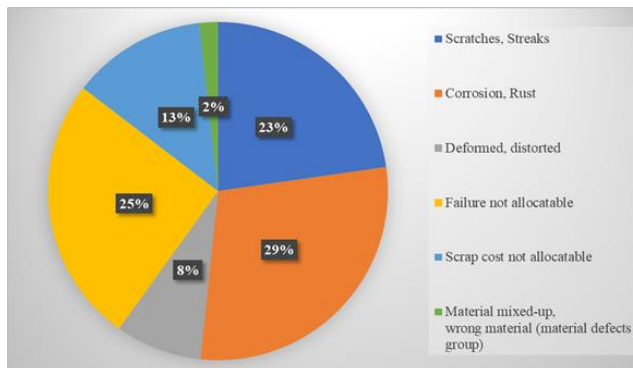
_No systemic data recorded to analyze and improve the process.

_No trigger point/system to provide the quick quality reaction plan

Analysis:

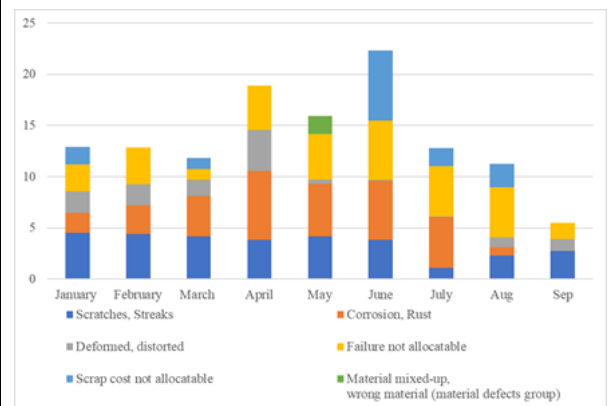
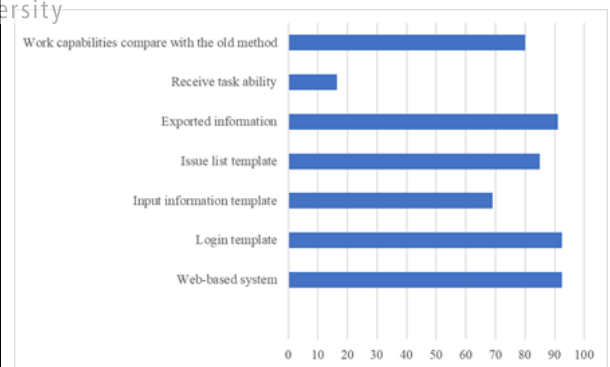
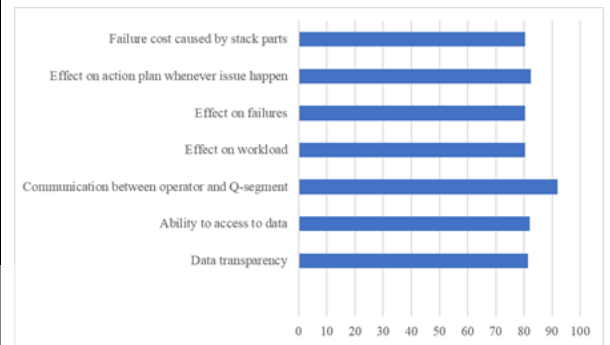


_Failure costs in the column chart above can be improve by applying the digital tools account for at least ten percent each month.



_The group of defects caused by stacked parts in the stock area (Corrosion, scratches, deform)

Results Report:



In general, most of the objectives of the

<p>accounts for over sixty percent of the total. The other group will use the data recorded on the web-based system to make an analysis and give potential solutions to make improvements.</p>	<p>project have been achieved. The failure costs have slightly decreased in the first month of piloting. In the following month, the cost accounted for only 5.38 percent in total. However, there are still concerns, drawbacks from the end-users:</p> <ul style="list-style-type: none"> _The “Receive task ability/ Communication between operators and managers” category was not achieved: Operators need to access the computer station to be notified about the assigned tasks, otherwise the tasks will not be known. _The “Input information template” receives only sixty-nine percent (the student will concentrate on solving the category has a score lower than eighty percent): Operators feedback that there are too many defect codes, and they cannot remember all of it. _The operator is unfamiliar with utilizing a web-based system. _Q-segment needs the data to export specific columns, rows of data to a specific excel file on the computer.
<p><u>Goal:</u></p> <ul style="list-style-type: none"> _Use the system as a quick response quality control in the process to eliminate failures. _Use the system’s data to analyze and improve the process. _Follow up with the project by using the PDCA cycle for continuous improvement. _Reduce downtime of solving suspicious parts. _Increase the data transparency. 	<p><u>Follow Up Action:</u></p> <ul style="list-style-type: none"> _Develop a system that after the Q-segment assigns tasks on the system, the system will automatically send a message to the private phone of the assigned operator. _Improve the web-based system to fit with the expectation from the feedback of the end-user. _Continue monitoring for improvement.

<p>_Increase the effectiveness of handling suspected parts => clear WIP in stock area => limits failure cost due to stack parts in the stock area for a long time.</p> <p>_Improve the end-user satisfaction when applying the digital tool to production</p> <p>_Reduce the workload of the operator by applying the web-based system.</p>	<p>_Print out a paper of the defect code list and attach it right next to the CoSP station.</p> <p>_Construct a suggestion menu list, which will make it easier for the operators to enter information into the information box.</p> <p>_Conduct more training courses to ensure that the operators become familiar with using the computer at the outset, followed by training on how to operate the system efficiently in the long run.</p> <p>_Print out the work instruction that will be used in conjunction with the training sessions and attach it to the CoSP station.</p> <p>_Develop solution while exporting the data, Q-segment able to choose which columns, rows he wants to export, export to which file he want to.</p>
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Table 8. A3 Report Summarize the Project

The A3 report shows that the project's goal is to develop a web-based system that will allow the company to store data on quantities of suspicious pieces defects while also allowing the operators and managers to communicate over the internet. Summary: The system will be used as a quick response action plan whenever issues arise, and the data recorded on the system will be analyzed to make improvements, allowing the company to reduce downtime of problem-solving parts, increase the efficiency of clearing suspicious parts, and reduce the costs of unexpected failures. Furthermore, the solution intends to improve data transparency throughout the organization while simultaneously reducing the workload of both operators and Q-segments.

Although the majority of the categories were met during the trial, the system received a number of negative comments from the operators and Q-segment as well. For continual quality improvement, the project's new objectives will describe how to assess, evaluate, and apply potential solutions that were proposed by the student during the act phase, which will be discussed in more detail later. Once the solutions have been implemented,



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the project will proceed with the use of the PDCA cycle to evaluate and monitor the progress of the project in order to make the necessary adjustments as they arise.



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APPENDICES

The survey

Efficiency	Overall score (on scale 200)	Overall score (Percentage)	Overall attitude of end-user: <ul style="list-style-type: none"> ○ > 5: positive ○ = 5: neutral ○ < 5: negative
Data transparency	163	81.5%	95%
Communication between operator and Q-segment	184	92%	100%
Effect on workload	161	80.5%	100%
Effect on failures	161	80.5%	100%
Effect on action plan whenever issue happen	165	82.5%	95%
Failure cost caused by stack parts	161	80.5%	100%

Satisfaction	Overall score (on scale 200)	Overall score (Percentage)	Overall attitude of end-user: <ul style="list-style-type: none"> ○ > 5: positive ○ = 5: neutral ○ < 5: negative
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Web-based system	164	92.5%	100%
Login template	185	92.5%	100%
Input information template	138	69%	85%
Issue list template	170	85%	100%
Exported information template	182	91%	100%
Receive task ability	33	16.5%	0%
Work capabilities compared with the old method	160	80%	100%

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