Failure Analysis Process Leadtime Reduction in a Manufacturing Company through Eliminate, Combine, Re-arrange, and Simplify (ECRS) Concept

Gerlyn Calica Altes, Klint Allen A. Mariñas, Michael N. Young, and Yogi Tri Prasetyo
School of Industrial Engineering and Engineering Management
Mapúa University
658 Muralla St., Intramuros, Manila 1002, Philippines
gcaltes@mymail.mapua.edu.ph, kaamarinas@mapua.edu.ph, mnyoung@mapua.edu.ph,
ytprasetyo@mapua.edu.ph

Klint Allen A. Mariñas and Yung-Tsan Jou
Department of Industrial and Systems Engineering
Chung Yuan Christian University
Taoyuan City, Taiwan
klintallen2011@gmail.com, ytjou@cycu.edu.tw

Reny Nadlifatin
Department of Information Systems,
Institut Teknologi Sepuluh November, Kampus ITS Sukolilo,
Surabaya 60111, Indonesia
reny.nadlifatin@gmail.com

Abstract

Reducing process lead time is one of the manufacturing industries' challenges to boost productivity and minimize the time required to develop new products. One of the processes that may improve further during new product development is the Failure Analysis Process. It is finding the root cause of a failure to address the issue and prevent future failures. The Failure Analysis Process of Company-ABC, a hard-disk drive manufacturer, was evaluated in this study to optimize the process and reduce investigation lead time by fifty percent. A shorter investigation lead time benefits the company since it enables faster discovery and correction of errors, hence expediting the development of new products. Process improvement can be achieved in various ways, one of which is by applying ECRS concepts (Eliminate, Combine, Rearrange, and Simplify), which involves eliminating insignificant activities, combining or rearranging the order of related activities, and simplification of activities. The VA/NVA (Value Added and Non-Value Added) and 5M1E (Man, Machine, Method, Material, Measurement, Environment) analysis can help determine which tasks have opportunities for improvement and optimization through ECRS. Company-ABC was able to halve the duration of the investigation by utilizing the ECRS concepts. All activities that underwent ECRS were discussed with the process's team members to ensure that all potential effects were understood before implementation. Finally, issues that develop due to process optimization will be monitored and documented constantly to help pinpoint specific areas in need of further improvement.

Keywords
Process Design, Leadtime Reduction, VA/NVA, 5M1E, ECRS concepts

1. Introduction
Company-ABC manufactures a broad range of innovative hard disk drive (HDD) devices to meet the demand of the global storage market. HDD is one of the critical devices and the most vital personal computer component, according to (David and Hennessy 2005). Since HDDs are mechanical devices, these will all ultimately fail. While some may

not fail early, many hard drives fail due to worn-out parts. The HDD often fails quickly if a problem is present in production. An entire Failure Analysis Engineering process must bear the responsibility to provide an effective system for cataloging, tracking, and data collection essential for failure analysis. Such analysis has to be performed on all failed drives received. The ultimate goal of the failure analysis process is to arrive at an accurate identification of the cause of failure.

Company-ABC has two plants in the Philippines. Product Design Support Department is in one of these plants. The support department handles manufacturing/developing, evaluating, testing, and analyzing the failures that will arise in new product prototypes. And to achieve the "First-to-market" condition, Company-ABC must expedite the development of new products. One of the critical processes that can be improved to shorten development time is the Failure Analysis process. According to (TWI n.d.), failure analysis is the process of determining the root cause of a failure, typically to resolve the issue and prevent future reoccurrences of these failures. Failure analysis is carried out across the manufacturing industry to avoid future asset and product failures and safeguard against potentially dangerous risks to people and the environment. The company will benefit from a shorter investigation lead time because it will result in faster detection and correction of errors, hence expediting the development of new products.

As explained by (Kumjeera et al. 2007), the Failure Analysis process can be categorized into four levels. The first level (Electrical Analysis or Isolation) determines whether or not the problem is chargeable; this critical issue is prioritized. The second level (Electrical Analysis or Identify symptom) entails determining a symptom and its probable underlying cause. The third level (Mechanical Analysis) comprises dissecting a failure symptom into component parts, while the fourth level (Component Teardown Analysis) entails analyzing the true nature of the material and critical component or elements such as Head, Disk, and Printed Circuit Board.

Based on the observations, the Failure Analysis process of the Product Design Support Department of Company-ABC requires a significant amount of time, particularly for log analysis, bench duplications, and characteristics measurements. The objective of this study, therefore, is to determine how to optimize the Failure Analysis Process of Company-ABC in order to reduce investigation lead time by fifty percent. Process optimization can be accomplished in a variety of ways. In this study, process optimization and improvements were carried out with VA/NVA, 5M1E analysis and ECRS concept. The ECRS (Eliminate, Combine, Re-arrange, and Simplify) involves eliminating insignificant activities, combining related rearranging the order of activities, simplification of activities. The VA/NVA (Value Added and Non-Value Added) and 5M1E (Man, Machine, Method, Material, Measurement, Environment) analysis helped determine which tasks would be an opportunity for improvement and can be optimized through application of ECRS concepts. The ECRS Lean technique emphasizes the rapid implementation of new ideas following a brainstorming session with task performers to identify potential improvement opportunities. With that said, the majority of newly framed processes do not require financial investment; instead, they should focus on restructuring and improving existing procedures. The benefit of ECRS is its adaptability; if something does not perform as expected, it can be altered without incurring further costs for an unproven solution.

The scope of this study is the Second Level of Failure Analysis Process of Company-ABC but limited to the Read-Write type of failures being encountered during reliability testing of the new products being developed. This paper is structured as follows: Chapter2 includes a review of the literature on the application of VA/NVA, 5M1E and ECRS in multiple fields. In Chapter4, the obtained failure analysis process map was analyzed and optimized, primarily utilizing the ECRS concept which was discussed in Chapter3. In Chapter5, the results in the investigation lead time of Failure Analysis process after applying the chosen method were discussed. Chapter6 summarizes and concludes the study with a suggestion for future research.

2. Literature Review

This chapter highlights the literature review conducted in several areas, emphasizing on VA/NVA and ECRS applications. These include the following:

Fadlil and Rosyidi (2020) conducted research on how to meet production targets through process and method improvements, including identifying wasteful work elements that do not add value to the product using VA/NVA analysis; eliminating, combining, reducing, and simplifying work processes using the ECRS method; and minimizing production cycle time through line balancing. Their findings indicate that by combining VA/NVA analysis, ECRS, and branch and bound algorithms to optimize line balancing, it is able to enhance the functionality of each work station, raise balance efficiency, lowered balance delay, and reduce maximum cycle time or service time, all of which contribute to meeting production targets.

In the case study of (Ng et al. 2013), they adopted the Value Stream Mapping (VSM), which they defined as a comprehensive tool that allows an organization to identify waste sources and implement processes improvements. Their paper identified all the value-added and non-value-added activities in their process. Non-value-added activities were reduced or removed by assigning butterfly operators to perform these tasks. The new system successfully resulted in reducing six headcounts in their process, which is equivalent to a saving of approximately eighty-seven thousand Malaysian ringgits per annum. This systematic approach can be similarly employed by lean practitioners to conduct lean activities in other manufacturing sectors.

In the study of (Nisa et al. 2021) at a data storage manufacturer, they discovered an imbalance in the manufacturing lines after observing these. According to them, the work method is one component of a working system that can be enhanced. In their study, they applied the concepts of Eliminate, Combine, Re-arrange, and Simplify to work technique improvements (ECRS). The benefit of their research was that the company was able to improve the work system on its production line because of the proposed work techniques, hence increasing the company's productivity. Additionally, following the process improvement, they were able to increase their line's efficiency from 65.62% to 74.43%.

Waghodekar (2021) demonstrated that assembly line productivity may be significantly increased by utilizing simple methods such as task simplification. His paper discusses an engine assembly line that operates both offline and online. The data collection for the current assembly lines was conducted using Time and Motion principles, with five observations made for each activity at each work station. The data is subsequently submitted to work simplification with the goal of reducing cycle time by considering such essential tasks as feasibility of deletion, combination, rearrangement, and simplification.

Sriputtha and Kositwat (2019) were able to reduce waste in detergent packaging by applying ECRS concepts. In their study, the process flow chart was used to examine data for ECRS improvement. As a result, redundant workflows are removed, and related jobs are consolidated. The production line and worker positions are also restructured. The process personnel were reduced from 12 to 9, saving approximately 54,000 THB per month. The cycle times of machines A and B were reduced from 397 to 319 seconds and 354 to 319 seconds, respectively. Lower cycle times were achieved after reducing the product flow distances of each machine. Finally, line balancing was raised from 72% to 92%.

Kittichotsatsawat and Tippayawong (2021) evaluated and recommended ways to improve the performance of coffee producers by engaging farmers, factories, and entrepreneurs with the use of lean techniques and intelligent farming. Value stream mapping (VSM) was used to identify and classify the coffee supply chain processes. Data was collected through site visits, observation, and interviews. Eliminate, Combine, Rearrange, and Simplify (ECRS) concepts were proposed to contribute to the improvement and expansion of the Thai coffee supply chain's profitability. The effects of implementing ECRS will be verified through a case study. Farmers and industry can benefit from increased responsiveness to customer demand in the future.

The gathered related works aided the researcher in better comprehending the usage and benefits of VA/NVA and ECRS. Through these literature examples, the researcher was convinced and became more confident that reduction of failure analysis investigation lead time is achievable using these chosen methodologies. Additionally, the researcher discovered that simply streamlining processes in any manufacturing industry would result in significant process improvements.

3. Methods

In this study, ECRS concepts, with the help of VA/NVA and 5M1E analysis, was employed. The existing condition of the Failure Analysis Process flow was assessed, and opportunities for improvement were determined. VA/NVA (Value Added/Non-Value Added) analysis is done by evaluating which and how many of the process map's activities do add value to the group and the group has direct control of modifying and improving. Before proceeding to the ECRS, 5M1E analysis was conducted to ascertain the underlying issues or concerns in each step. After gaining a grasp of the issues and determining their root causes, the next step is determining which ECRS concept is suitable for the respective process steps. 5M1E, which stands for "Manpower, Machine, Measurement, Material, Methods, and

Environment." is a root cause analysis tool, which involves asking questions about the 5Ms & E until the root cause of the problem is discovered (N.Saad 2017). 5M1E is commonly seen in Ishikawa Diagram or Fishbone Diagram. According to ("Fishbone diagram: Solving problems properly," n.d.) Ishikawa Kaoru, a Japanese scientist, devised the Fishbone Diagram. Ishikawa Diagram strives to assist companies in an organized manner in identifying solutions to problems and their causes. Each problem requiring a long-term solution is graphically depicted alongside its corresponding causes. The problem that must be resolved is depicted on the right side of the diagram. The possible root cause is depicted on the diagram's left side.

ECRS stands for Eliminate, Combine, Rearrange, and Simplify. According to ("ECRS Lean Definition," n.d.), this Lean approach concept is generally used to remove or significantly decrease wasteful steps in manufacturing processes and even office procedures. With the use of ECRS, complicated and time-consuming tasks are examined with the purpose of successfully executing one or more of the ECRS acronym's strategies. The first acronym, according to (Shmula 2012), Eliminate, is critical for identifying tasks that can be eliminated quickly. When an activity or task is impossible to eliminate, combine them. The step of combination addresses the Who, Where, and When questions. Tasks can also be reorganized. Furthermore, a general rule of thumb is to keep things simple regardless of the circumstance. Naturally, we want to eliminate first, but if that is not possible, we can benefit from Combining, Rearranging, and Simplifying.

4. Data Collection

The data collected included the sequential tasks performed by the Second Level Failure Analysis Engineering Group and the amount of time spent on each activity. The clock time for each activity, which is the average clock time of the eighteen members of the group, is detailed and tabulated in Table 1. The process flow of Failure Analysis Engineering is illustrated in Figure 1.

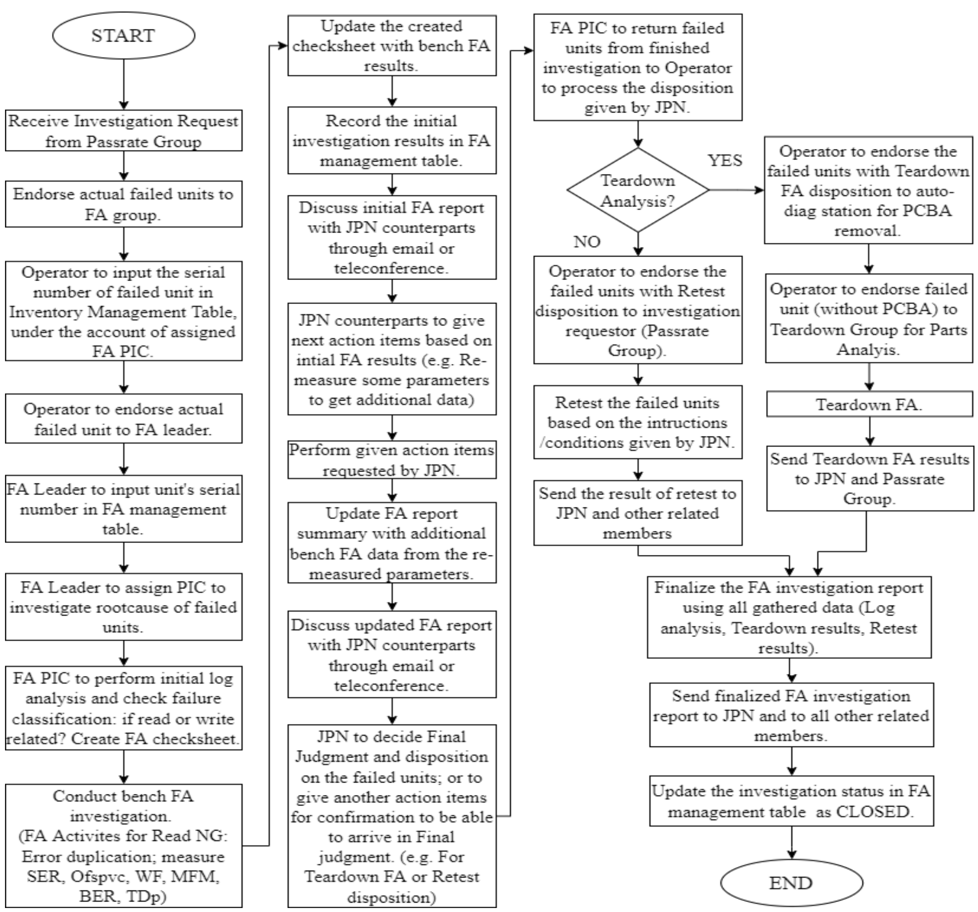

Figure 1. Process Mapping of Failure Analysis Engineering

Table 1. Clock time per Failure Analysis Activities

Step No.	Process Detail	Processing / Tasks	Transport / Moving	Stagnation / Waiting	Inspection	VA or NVA?	Clock Time (min.)
1	Receive investigation request from Passrate Group.	•		•		NVA	--
2	Endorse actual failed units to FA group.	•	•			NVA	--
3	Operator to input the serial number of failed units in Inventory Management Table, under the account of assigned FA PIC.	•				VA	5
4	Operator to endorse actual failed unit to FA leader.		•			NVA	5
5	FA Leader to input unit's serial number in FA management table.	•				VA	2
6	FA Leader to assign PIC to investigate root cause of failed units.	•				VA	5
7	FA PIC to perform initial log analysis and check failure classification: if read or write related? Create FA-checksheet	•		•		VA	205
8	Conduct bench FA investigation. (FA Activities for Read NG: Error duplication and measure drive characteristics)	•		•		VA	240
9	Update the created FA-checksheet with bench FA results.	•		•		VA	120
10	Record the initial investigation results in FA management table.	•				VA	2
11	Discuss initial FA report with JPN counterparts through email or teleconference.	•				NVA	120
12	JPN counterparts to give next action items based on initial FA results (e.g. Re-measure some parameters to get additional data)	•		•		VA	--
13	Perform given action items requested by JPN.	•		•		VA	90
14	Update FA report summary with additional bench FA data from the re-measured parameters.	•		•		VA	60
15	Discuss updated FA report with JPN counterparts through email or teleconference.	•				VA	120
16	JPN to decide Final Judgment and disposition on the failed units; or to give another action item for confirmation to be able to arrive in Final judgment. (e.g. For Teardown FA or Retest disposition)	•		•		VA	--
17	FA PIC to return failed units from finished investigation to Operator to process disposition given by JPN.	•	•			VA	30
18	Operator to endorse the failed units with Teardown FA disposition to auto-diag station for PCB removal.	•	•	•		NVA	30
19	Operator to endorse failed unit (without PCB) to Teardown Group for Parts Analysis.	•	•	•		NVA	10
20	Teardown FA.			•	•	NVA	--
20	Operator to endorse the failed units with Retest disposition to investigation requestor (Passrate Group).	•	•	•		NVA	--
21	Send Teardown FA results to JPN and Passrate Group.	•		•		NVA	--
21	Retest the failed units based on the instructions/conditions given by JPN.	•		•		NVA	--
22	Send the result of retest to JPN and other related members.	•		•		NVA	--
23	Finalize the FA investigation report using all gathered data (Log analysis, Teardown results, Retest results).	•				VA	15
24	Send finalized FA investigation report to JPN and to all other related members.	•				VA	5

25	Update the investigation status in FA management table as CLOSED.	•				VA	2
Total count of Activities/Steps in FA Process							25
Total Clock Time (minutes)							1066

These data can be used to identify and optimize the activities with the longest clock time, and according to this, Failure Analysis consists of 25 actions with a total lead time of 1066 minutes. Steps 7 and 8, which are linked with log analysis and bench FA, respectively, have the most clock time. Log analysis requires manually plotting and graphing data in Microsoft Excel. Bench FA is used to duplicate errors and perform characteristic measurements, which necessitates the creation of schedule scripts for each failed unit that needs to be identified. Because doing these steps manually takes time, it is reasonable to seek a solution that will enable these tasks to run easily and effectively. All identified steps were analyzed in greater detail in collaboration with process team members in order to comprehend and identify appropriate improvement items.

5. Results and Discussion

5.1 Result of VA/NVA Analysis

Based on the analysis, there are eleven NVA's and sixteen VA's. All value-added operations were prioritized to be subjected to the ECRS concept as part of the process optimization effort to shorten the group's lead time for failure analysis investigation. However, there are six NVA's that were also subjected in the ECRS, two of which were eliminated and the remaining were combined. NVA is any action that does not add value to a product or service. Minimizing lead time can be done by identifying and removing as many non-value-added actions as possible ("Non-Value-Added Definition," n.d.). The NVA services are not intrinsically wrong. Each process entails non-value-added actions necessary for the product or service to be completed. The majority of actions in service processes fall under this category. However, because NVAs use resources, these should be avoided or minimized whenever possible ("Non-Value-Added (NVA) Definition," n.d.).

5.2 Result of 5M1E Analysis

In Table 2, the results of the 5M1E analysis are shown, and it can be observed that five concerns are affecting the lead process time. These include the following: (1) Accuracy and completeness of FA Data, (2) Required dedicated PIC, (3) Longer processing time, (4) Difficulty in HDD traceability and (5) Difficulty in HDD control. Root causes identified for these concerns are notably concentrated to Man and Method. Based on these findings, suitable ECRS action will be selected. In Table-2, the results of the 5M1E analysis are shown, and it can be observed that five concerns are affecting the lead process time. These include the following: (1) Accuracy and completeness of FA Data, (2) Required dedicated PIC, (3) Longer processing time, (4) Difficulty in HDD traceability and (5) Difficulty in HDD control. Root causes identified for these concerns are notably concentrated to Man and Method. Based on these findings, suitable ECRS action will be selected.

Table 2. Root cause Analysis using 5M1E

Step No.	Process steps for improvement	Concerns	Root cause Analysis using 5M1E	Recommended Action using ECRS
3	Operator to input the serial number of failed units in Inventory Management Table, under the account of assigned FA PIC.	Difficulty in HDD traceability	Method	Simplify (S)
4	Operator to endorse actual failed unit to FA leader.	Difficulty in HDD control	Method	Eliminate (E)
5	FA Leader to input unit's serial number in FA management table.	Requires dedicated PIC	Man	Combine (C1)
6	FA Leader to assign PIC to investigate root cause of failed units.	Requires dedicated PIC	Man	Combine (C1)
7	FA PIC to perform initial log analysis and check failure classification: if read or write related? Create FA-checksheet.	Longer processing time	Method	Simplify (S)

8	Conduct bench FA investigation. (FA Activities for Read NG: Error duplication and measure drive characteristics)	Longer processing time	Method	Simplify (S)
9	Update the created FA-checksheet with bench FA results.	Longer processing time	Method	Simplify (S)
11	Discuss initial FA report with JPN counterparts through email or teleconference.	Inaccuracy & incompleteness of FA data	Man	Eliminate (E)
12	JPN counterparts to give next action items based on initial FA results (e.g. Re-measure some parameters to get additional data)	Inaccuracy & incompleteness of FA data	Man	Re-arrange (R)
13	Perform given action items requested by JPN.	Longer processing time	Method	Simplify (S)
14	Update FA report summary with additional bench FA data from the re-measured parameters.	Longer processing time	Method	Simplify (S)
15	Discuss updated FA report with JPN counterparts through email or teleconference.	Inaccuracy & incompleteness of FA data	Man	Simplify (S)
16	JPN to decide Final Judgment and disposition on the failed units; or to give another action item for confirmation to be able to arrive in Final judgment. (e.g. For Teardown FA or Retest disposition)	Inaccuracy & incompleteness of FA data	Man	Simplify (S)
17	FA PIC to return failed units from finished investigation to Operator to process disposition given by JPN.	Difficulty in HDD traceability	Method	Simplify (S)
18	Operator to endorse the failed units with Teardown FA disposition to auto-diag station for PCBA removal.	Requires dedicated PIC	Man	Combine (C2)
19	Operator to endorse failed unit (without PCBA) to Teardown Group for Parts Analysis.	Requires dedicated PIC	Man	Combine (C2)
21	Retest the failed units based on the instructions/conditions given by JPN	Requires dedicated PIC	Man	Combine (C3)
22	Send the result of retest to JPN and other related members	Requires dedicated PIC	Man	Combine (C3)
23	Finalize the FA investigation report using all gathered data (Log analysis, Teardown results, Retest results).	Requires dedicated PIC	Man	Combine (C4)
24	Send finalized FA investigation report to JPN and to all other related members.	Requires dedicated PIC	Man	Combine (C4)

5.3 Result of Applying ECRS Concept

ECRS's ultimate goal is to simplify any procedure for employees and result in a more efficient operation on a holistic level. The following are the four strategies: (1) Eliminate - Determine which steps can be eliminated without compromising the process's value. (2) Combine – If no stages can be removed, consider combining these. (3) Rearrange — Rearranging steps may speed up, simplify, or safeguard the process. (4) Simplify - Simplifying steps can significantly improve the convenience of understanding and performing complicated activities. This strategy may also involve the automation of some tasks. Table 3 details the result of the collaboration and thorough discussions with the involved members and management of Failure Analysis Engineering. In summary, there were two steps that can be eliminated, and these are steps 3 and 8; four steps that can be turned into two steps by combining these; one step to be re-arranged; lastly, there are nine steps that are qualified for simplification and these are steps 3, 7 to 9, 13 to 17. From these, Steps 7 to 9, which have the highest clock time amongst other steps, will be simplified by task automation. An Excel Macro program, capable of automating the time-consuming and manual log data analysis and summarization process, was developed to simplify the task. Finally, the new process map for Failure Analysis Engineering after applying ECRS concept is illustrated in Figure 2.

Table 3. Clock time per Failure Analysis activities after applying ECRS concept

Step No.	Process Detail	Processing / Tasks	Transport / Moving	Stagnation / Waiting	Inspection	VA or NVA?	Original Clock Time (min.)	Applied ECRS technique	Clock Time after ECRS (min.)	Reduced Clock Time (min.)
1	Receive investigation request from Passrate Group.	•		•		NVA	--	--	--	--
2	Endorse actual failed units to FA group.	•	•			NVA	--	--	--	--
3	Operator to input the serial number of failed units in Inventory Management Table, under the account of assigned FA PIC.	•				VA	5	S	5	0
4	Operator to endorse actual failed unit to FA leader.		•			NVA	5	E	0	-5
5	FA Leader to input unit's serial number in FA management table.	•				VA	2	C1	2	0
6	FA Leader to assign PIC to investigate root cause of failed units.	•				VA	5	C1	5	0
7	FA PIC to perform initial log analysis and check failure classification: if read or write related? Create FA-checksheet	•		•		VA	205	S	23	-182
8	Conduct bench FA investigation. (FA Activities for Read NG: Error duplication and measure drive characteristics)	•		•		VA	240	S	180	-60
9	Update the created FA-checksheet with bench FA results.	•		•		VA	120	S	30	-90
10	Record the initial investigation results in FA management table.	•				VA	2	--	2	0
11	Discuss initial FA report with JPN counterparts through email or teleconference.	•				NVA	120	E	0	-120
12	JPN counterparts to give next action items based on initial FA results (e.g. Re-measure some parameters to get additional data)	•		•		VA	--	R	35	35
13	Perform given action items requested by JPN.	•		•		VA	90	S	60	-30
14	Update FA report summary with additional bench FA data from the re-measured parameters.	•		•		VA	60	S	30	-30
15	Discuss updated FA report with JPN counterparts through email or teleconference.	•				VA	120	S	90	-30
16	JPN to decide Final Judgment and disposition on the failed units; or to give another action item for confirmation to be able to arrive in Final judgment. (e.g. For Teardown FA or Retest disposition)	•		•		VA	--	S	--	--

17	FA PIC to return failed units from finished investigation to Operator to process disposition given by JPN.	•	•			VA	30	S	5	25
18	Operator to endorse the failed units with Teardown FA disposition to auto-diag station for PCB removal.	•	•	•		NVA	30	C2	30	0
19	Operator to endorse failed unit (without PCB) to Teardown Group for Parts Analysis.	•	•	•		NVA	10	C2	10	0
20	Teardown FA.			•	•	NVA	--	--	--	--
20	Operator to endorse the failed units with Retest disposition to investigation requestor (Passrate Group).	•	•	•		NVA	--	--	--	--
21	Send Teardown FA results to JPN and Passrate Group.	•		•		NVA	--	--	--	--
21	Retest the failed units based on the instructions/conditions given by JPN.	•		•		NVA	--	C3	--	--
22	Send the result of retest to JPN and other related members.	•		•		NVA	--	C3	--	--
23	Finalize the FA investigation report using all gathered data (Log analysis, Teardown results, Retest results).	•				VA	15	C4	15	0
24	Send finalized FA investigation report to JPN and to all other related members.	•				VA	5	C4	5	0
25	Update the investigation status in FA management table as CLOSED.	•				VA	2	--	2	0
After ECRS - Total count of Activities/Steps in FA Process										19
After ECRS - Total Clock Time (minutes)										529

By studying Tables 3, 4 and 5, it is evident that the Process Leadtime for Failure Analysis has improved greatly as a result of the ECRS concept's deployment. The total lead time was reduced from 1066 minutes with twenty-five steps to 529 minutes with only nineteen steps. The investigation lead time was significantly reduced by fifty percent, with the Simplify concept accounting for 41.93 percent of the time savings and a total of nine streamlined steps.

Table 4. Detail of the applied ECRS

Applied ECRS technique	VA or NVA?	Count of Steps/Activities	Reduced Clock Time (min.)	Reduced Clock Time (%)
E	NVA	2	-125	-11.73%
C1	VA	2	0	0
C2	NVA	2	0	0
C3	NVA	2	0	0
C4	VA	2	0	0
R	VA	1	+35	+3.28%
S	VA	9	-447	-41.93%
Grand Total		20	-537	-50.37%

Table 5. Summary of Results

Detail	BEFORE deploying ECRS	AFTER deploying ECRS	Target Time Reduction %	Actual Time Reduction %	REMARKS
Total Steps	25	19	50%	50.37%	Target Achieved
Total Average Lead time	1066 mins.	529 mins.			
Actual Reduced time	0 mins.	-537 mins.			

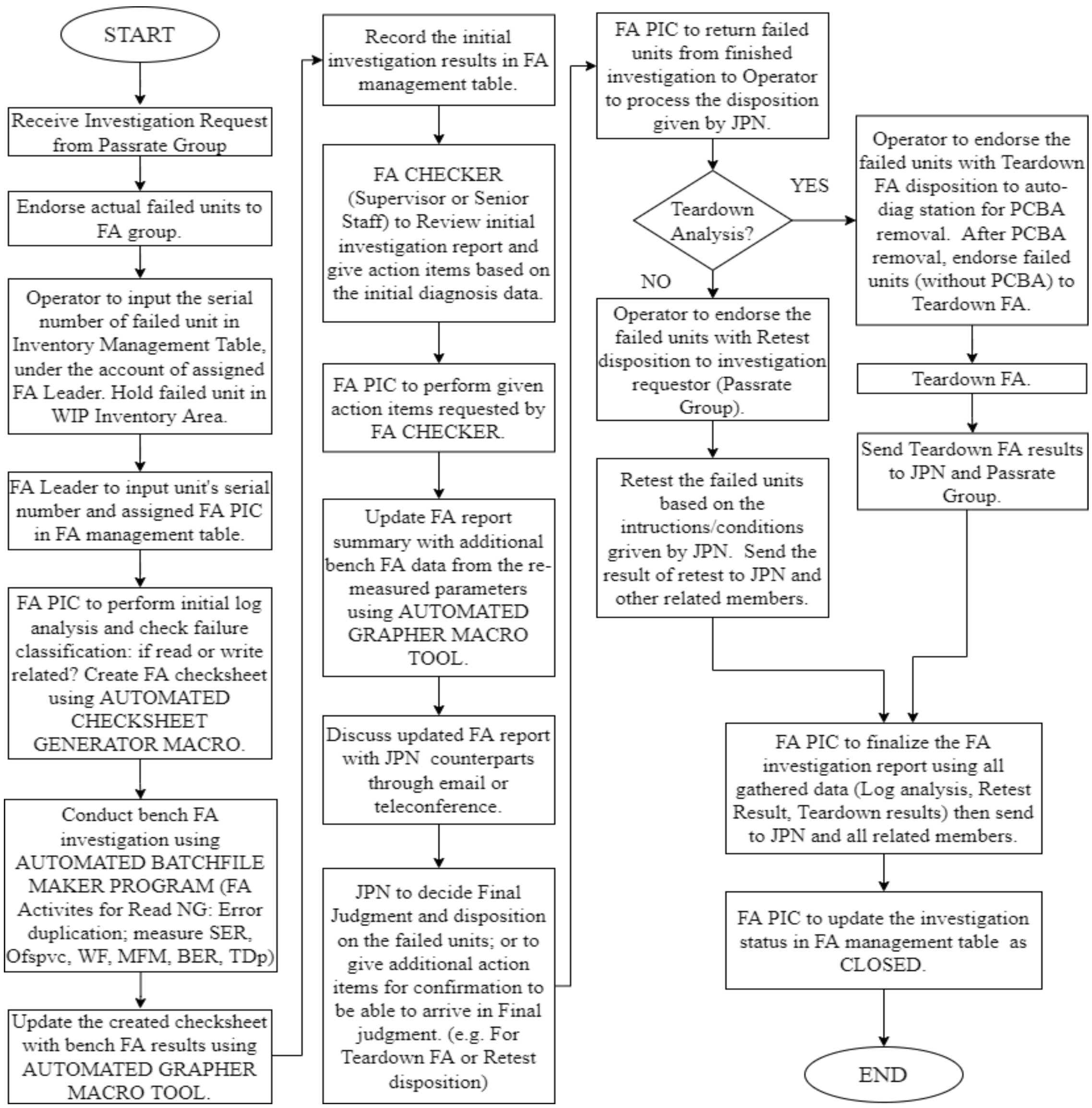

Figure 2. Process Mapping of Failure Analysis Engineering after ECRS application

5.4 Results Comparison with other studies

Presented in Chapter2 of this paper are some studies related to process improvement that has also employed VA/NVA Analysis, 5M1E, and has applied ECRS concepts, in which the authors have highlighted their results by comparing tact time and line efficiency before and after the application of ECRS concepts. In this study, the expected result is a 50% lead time reduction for a process that involves "service." Here, the result is highlighted by comparing tact time before and after applying ECRS concepts. This study does not have line efficiency verification since the process does not involve manufacturing of products. The totality of each member's completed investigation samples can be used to evaluate the ECRS's efficiency, however it may not be reliable due to variations in the number of failures or investigation requests.

6. Conclusion

Based on the result of the VA/NVA and 5M1E analysis, and the impact of the ECRS concepts on the process, it can be concluded that under the new process flow, the Failure Analysis Engineering Group of the Product Design Support Department of Company-ABC improved its investigation lead time and met the target of fifty percent reduction. With process improvement, the new lead time for the investigation was reduced to 529 minutes with nineteen steps. The significant improvement is primarily due to the simplification concept of ECRS, which led to the development of an excel macro to automate the manual log data analysis and script creation steps. These process improvements also eased and lessened the members' fatigue since the repetitive activity was simplified. It would be helpful for future research if processes associated with the FA group, such as Teardown Group, were also subjected to the same study since this would expedite the analysis and correction of failures encountered during new product development.

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Biographies

Gerlyn Calica Altes is a Failure Analysis Engineer in a Hardisk Drive Manufacturing Company who enjoys expanding her skillset. She graduated from the Technological University of the Philippines with a diploma in Instrumentation and Control Engineering Technology and an undergraduate degree in Electronics and Communications Engineering. She is currently pursuing a Master of Science in Engineering Management at Mapua University, School of Industrial Engineering and Engineering Management. This work is precious to her because significant time and effort have been invested in it.

Klint Allen A. Mariñas is a Ph.D. student at the Industrial and Systems Engineering Department, Chung Yuan Christian University in Taiwan. He earned his bachelor's degree in Industrial Engineering at Adamson University, Manila, Philippines, and his master's in Industrial Engineering degree at Mapua University, Manila, Philippines. He previously worked as a process engineer in a plastic manufacturing company in the Philippines for three years and eventually took his graduate studies focusing on production planning, human factors, ergonomics, and quality engineering. He is currently under the CIM and Smart Manufacturing laboratory working on ergonomics and production improvement studies.

Michael N. Young is an associate professor in the School of Industrial Engineering and Engineering Management at Mapúa University. He earned his B.S. Industrial Engineering & B.S. Engineering Management from Mapúa Institute of Technology (Philippines) and M.S. & Ph.D. in Industrial and Systems Engineering from Chung Yuan Christian University (Taiwan). His research interests include portfolio optimization and financial engineering.

Yogi Tri Prasetyo is an associate professor in the School of Industrial Engineering and Engineering Management, Mapua University, Philippines. He received a B.Eng. in industrial engineering from Universitas Indonesia (2013). He also studied at Waseda University Japan during his junior year (2011-2012) as an undergraduate exchange student. He received an MBA (2015) and a Ph.D. (2019) from the Department of Industrial Management National Taiwan University of Science and Technology (NTUST), with a concentration in human factors and ergonomics. Dr.Prasetyo has a wide range of research interest including color optimization of military camouflage, human-computer interaction particularly related to eye movement, strategic product design, accident analysis, and usability.

Reny Nadlifatin is a Lecturer in the Department of Information System, Institut Teknologi Sepuluh Nopember (ITS_, Surabaya. She obtained a double degree in Master of IT and Master of Business Administration from ITS and National Taiwan University of Science and Technology (NTUST). Meanwhile, she obtained doctoral degrees from the National Taiwan University of Science and Technology (NTUST).

Yung-Tsan Jou received his Ph.D. degree in Integrated (ME, ISE) engineering from Ohio University, Athens, OH, in 2003. He is an Associate Professor of Industrial and Systems Engineering at Chung Yuan Christian University, Taiwan. His research has made contributions in green design, human–system interface design, senior assistive devices, and usability or quality evaluation by using virtual reality tools, smart manufacturing, machine learning, and data analysis.