Effectiveness of Internal Manufacturing Audit on Quality Control Via Layered Process Audit

Dianti Arta Lumban Raja[1], Mia Syafrina[2], Jonathan Saimara Tarigan[3]

{diantiarta18@gmail.com[1], miasyafrina@polibatam.ac.id[2], jonathan.4132101009@students.polibatam.ac.id[3]}

Politeknik Negeri Batam, Business and Management Department, Batam City, Indonesia[123]

Abstract. This study aims to show the effectiveness of internal manufacturing audits on quality control through the implementation of a Layered Process Audit (LPA) in manufacturing companies. This type of research is descriptive qualitative by describing the criteria, conditions, causes, and effects regarding the implementation of LPA in the work process in the Quality Assurance (QA) department. Data were analyzed using the Miles and Huberman model, including data collection, reduction, presentation, conclusion drawing, and verification. The results showed that the internal manufacturing audit of quality control through LPA has been carried out effectively. The results also show that the implementation of LPA in incoming inspection and outgoing inspection in area X and incoming inspection in area Y has been carried out effectively on quality control, while in the final inspection work process in area Y, the implementation of LPA is still fairly effective on quality control.

Keywords: Effectiveness, Internal Audit, Quality Control, Layered Process Audit

1 Introduction

Manufacturing as a business type has seen tremendous changes in the business environment and technological advancements [1]. This has resulted in heightened corporate competition. With the business environment becoming increasingly competitive, every organization must strive for continual improvement [2]. An adequate evaluation is required to measure continuous improvement in order to constantly be able to improve it [3].

According to [4], one of the evaluations that are frequently carried out in firms is the internal control system, that is, through the deployment of internal audits. According to [5], one of the general aims of internal audits is to remedy nonconformities in corporate work practices in order to increase the efficiency of company operations. The internal audit of operational operations became the company's key focus in processing materials into completed products while maintaining product quality [6]. This is done to ensure that the company's operational functions have been carried out effectively, contributing to the company's success in accomplishing its objectives.

According to [7], the quality of products produced by the company must be maintained by using an internal audit program that can help verify the suitability of the production process. Layered Process Audit (LPA) is a process that ensures the conformity of work procedures and processes

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and their implementation by verifying [8]. According to [9], verifying means ensuring that all provisions are carried out and implemented in accordance with established standards.

PT XYZ is a manufacturing company located in Batam City and is one of the companies that adopted the LPA program. The implementation of LPA at PT XYZ serves as a system to verify whether inspectors are working in accordance with company standards. In implementing the LPA, PT XYZ schedules all staff who become LPA auditors to conduct LPA audits as part of the work process to verify inspectors have performed their duties in accordance with established company standards.

Based on interviews conducted by researchers with informants during the implementation of LPA at PT XYZ, findings were made in January 2022 in the form of a foreign object in product packaging, which resulted in consumers returning all products with the same Part Number (PN), or called customer return. The QA Department collaborates with the Engineering and Production Departments to conduct investigations to find the cause of the escape and corrective and preventive actions that need to be taken so that things no longer happen. After investigation, it was found that a small thread came from the rest of the table-cleaning cloth.

During the researcher's observation, an LPA internal finding record was found in the Packing Final Inspection area in June 2022 because, during the FOD check audit, the operator had not done the daily checklist, which should have been done at the beginning of the shift before doing work. This caught the attention of researchers because there is a history of customer returns with almost similar cases. Therefore, researchers chose the Quality Assurance (QA) department as the focus of this study. The QA department is one of the most important departments in the company because it is the initial and final gate of a business process before a product is sent to consumers, so there are findings.

2 Theory Review

2.1. Internal Audit

According to [10], internal audit is an organizational control that measures and evaluates the effectiveness of an organization. The information generated from the internal audit is intended for the organization's management. Internal auditors, often referred to as internal auditors, are employees of the organization and are responsible for the internal control of the company in order to achieve efficiency and economic compliance with the policies adopted by the company or organization. The purpose of the internal audit function is to assist management in improving the efficiency and effectiveness of the activities of a company or organization.

There are five stages of management auditing when conducting internal audits. First, the preliminary audit, which is the initial stage of the internal audit process. Second, management review and control aim to measure the extent to which management control supports the company in achieving its goals. Third, Advanced Audit: At this stage, the auditor groups information into conditions, criteria, causes, and effects. Fourth, reporting aims to communicate audit findings and recommendations to management for correction as soon as possible. Finally, Further Action is the implementation of the recommendations given by the auditor to the relevant parties to make improvements based on the auditor's recommendations [11].

2.2. Quality Control

According to [7], quality control can be defined as a technique in the management of a manufacturing plant or factory that ensures the production of goods of consistent quality. Producing goods of consistent quality indicates that the goods are manufactured in accordance with predefined quality standards. Product quality is also influenced by the operational processes from the initial stages to the final delivery to consumers. In other words, quality control is an integrated activity that encompasses the management of material quality standards, production process standards, semi-finished goods, finished goods, and delivery standards of final products to consumers, ensuring that the goods are produced according to the planned quality specifications.

Quality essentially serves as a competitive weapon and is utilized to provide assurance to customers. According to [12], indicators of achieving quality control include quality control in the production department, specifically the routine inspection and maintenance of production machinery, as well as the accurate and timely implementation of production.

2.3. Layered Process Audit

According to [8], a layered process audit (LPA) is a tool used to verify that work is performed according to established standards. The LPA emphasizes the importance of these standards and identifies opportunities for continuous improvement. LPAs can be used to validate established processes within an organization. A process is a set of activities and control measures related to the manufacture of a product.

The method of this activity in the manufacturing business is presented by the organization Automotive Industry Action Group AIAG through the creation of the "CQI 8 Layer Process Audit Guidelines (LPA)", and it explains that one of the benefits of LPA is the efficient utilization of LPAs by management to verify and validate process compliance, identify potential deviations, and offer possibilities for ongoing improvement. The outcomes have a direct influence on the quality of products provided to customers, and organizational enhancements have a positive effect on the organization's business results.

3. Research Method

The research method employed is descriptive analysis with a qualitative approach. The research is conducted at PT XYZ, a manufacturing company specializing in aircraft spare parts production located in Batamindo Industrial Park, Batam City. The sampling technique is non-probability sampling, specifically purposive sampling. The informants and subjects selected include one manufacturing engineer, two quality engineers, one cell specialist, and one document control clerk.

Data collection techniques in this research are field research and library research. The data analysis technique used in this study uses the Miles and Huberman model. According to [13], analytical steps are carried out by means of data collection, data reduction, data presentation, conclusion withdrawal and verification. To analyze observation data adopted from the audit checklist LPA in PT XYZ. The study of the effectiveness of the LPA audit process was

conducted by responding to indicators with two-choice answers, namely "Pass" meaning conformance, and "Fail" meaning nonconformance.

The calculation steps are as follows:
1) Count the number of indicators with the answer “Pass”
2) Divide the number of pass answers by the total number of answers and multiply by 100%.

The effectiveness formula is as follows:

$$\text{Process Effectiveness} = \frac{\text{Number of "Pass" Answers}}{\text{Total Answers}} \text{x } 100\% \quad (1)$$

With the interpretation of the values, i.e.,

Table 1. Interpretation of the Effectiveness Score

Percentage	Criteria
91-100%	Effective
81-90%	Moderately Effective
60-80%	Less Effective

Source: Adaptation of [13]

Each value obtained from the calculation will determine the effectiveness of LPA in each work process for quality control at PT XYZ.

Furthermore, the researcher will draw conclusions from the data obtained through observations, interviews, literature research, and field notes. The conclusions reached in this study will be verified by examining the results of the research on the effectiveness of LPA in quality control using the audit checklist assessment on the observation sheet. Additionally, the researcher will describe the data in a clear and understandable manner, aligning with the research objectives.

4. Result and Discussion

One of the internal manufacturing audits at PT XYZ is the LPA internal audit. The LPA internal audit is conducted monthly, covering all areas of the work process randomly, and is performed by auditors who rotate between different areas. This LPA program is an initiative of the central corporation, and it is important to consider that the submitted statements are more relevant to the situation in the audited work process. However, for the most part, the LPA statements are appropriate and meet the requirements effectively.

The implementation of LPA at PT XYZ aims to verify compliance with safety, operational, quality, and customer requirements. LPA audits are conducted by auditors who are trained by quality engineers, quality managers, or external institutions. In the implementation of the LPA, the auditor will conduct the audit using the checklist for the LPA stored in the EASE system. This system will provide a documented audit record of process compliance with established procedures.

In the preliminary audit, researchers conducted an early-stage survey of PT XYZ to gather information about the company's background and identify existing problems. The researchers conducted observations and interviews with the selected informants. In the review and quality control stages, researchers re-examined the evidence obtained to determine the audit findings and purpose. In an advanced audit, the data obtained is then classified into four elements of the audit findings and analyzed to understand the problems that occur until an audit conclusion is reached. The following are the results of an advanced audit of the implementation of the LPA in the QA department for four work processes, namely:

Table 2. Advanced Audit Grouping: Incoming Inspection Area X

Conditions	**Criteria**
The incoming inspection process in area X at PT XYZ is carried out based on standards and procedures by the QA department. It can be seen from the results of the LPA audit that no findings were found during the LPA audit process.	1) AS9100 - Aerospace Quality Management System, 2) AS9102 - Aerospace First Article Inspection Requirement, 3) ISO0IEC 17025:2017 - General requirements for the competence of testing and calibration laboratories, 4) ISO 14001:2015 - Environmental Management System, 5) AS9110 - Maintenance, Repair, and Overhaul-MRO, 6) ISO 45001:2018 – Occupational Health and Safety Management System, 7) ISO 31000:2018 – Risk Management
Causes	**Effects**
The incoming inspection process in Area X is carried out in accordance with the needs of the QA department. The inspectors have done their job by checking the materials received from suppliers to ensure quality and conformity to requirements before being used by production.	The QA department has been able to obtain materials that best meet the requirements set in the incoming inspection process for Area X. In addition, ensuring that only high-quality materials are used in the production process can improve the quality of the products produced.

Calculation of process effectiveness:

Table 3. Observation of Incoming Inspection Area X

Indicator	**Answer**		**Total**
	Pass	**Fail**	**Answers**
Process Control	4	0	4
Measuring and Testing Equipment	3	0	3
Safety and Environment	2	0	2
Foreign Object Damage (FOD)	3	0	3
Special Requirements	1	0	1
Total Productive Maintenance	2	0	2
Total	**15**	**0**	**15**

$$\text{Process Effectiveness} = \frac{\text{Number of "Pass" Answers}}{\text{Total Answers}} \text{x } 100\ \% = \frac{15}{15} \text{x } 100\ \% = 100\ \% \quad (2)$$

The incoming inspection area X process shows a 100% effectiveness rate, so it is categorized as an effective criterion. This result shows that the audit items have been carried out well, which means that standards and regulations have been met well and quality control in incoming inspection area X is running effectively.

Table 4. Advanced Audit Grouping: Outgoing Inspection Area X

Conditions	Criteria
The outgoing inspection process in area X at PT XYZ is carried out based on standards and procedures by the QA department. It can be seen from the results of the LPA audit that no findings were found during the LPA audit process.	1) AS9100 - Aerospace Quality Management System, 2) AS9102 - Aerospace First Article Inspection Requirement, 3) ANSI/ASQ - Sampling Procedures and Table for Inspection, 4) ISO 14001:2015 - Environmental Management System, 5) AS9110 - Maintenance, Repair, and Overhaul-MRO, 6) ISO 45001:2018 - Occupational Health and Safety Management System, 7) ISO 31000:2018 – Risk Management
Causes	**Effects**
The outgoing inspection process in Area X is carried out according to the needs of the QA department. The inspectors have done their job by ensuring that the product has passed all stages of production, is inspected in the same way, and is ready to be sent to consumers.	The QA department has been able to get products that meet the standards sent to consumers. This also provides quality assurance and confidence that the products received by consumers are in accordance with the requirements that have been set.

Calculation of process effectiveness:

Table 5. Observation of Outgoing Inspection Area X

Indicator	Answer		Total Answers
	Pass	Fail	
Process Control	4	0	4
Measuring and Testing Equipment	3	0	3
Safety and Environment	2	0	2
Foreign Object Damage (FOD)	3	0	3
Special Requirements	1	0	1
Total Productive Maintenance	2	0	2
Total	**15**	**0**	**15**

$$\text{Process Effectiveness} = \frac{\text{Number of "Pass" Answers}}{\text{Total Answers}} \text{x } 100\ \% = \frac{15}{15} \text{x } 100\ \% = 100\ \% \quad (3)$$

The outgoing inspection process for area X shows a 100% effectiveness rate, so it is categorized as an effective criterion. This result shows that the audit items have been carried out well, which means that standards and regulations have been met well and quality control in the outgoing inspection area X is running effectively.

Table 6. Advanced Audit Grouping: Incoming Inspection Area Y

Conditions	Criteria
The incoming inspection process in area Y at PT XYZ is carried out based on standards and procedures by the QA department. It can be seen from the results of the LPA audit that no findings were found during the LPA audit process.	1) AS9100 - Aerospace Quality Management System, 2) AS9102 - Aerospace First Article Inspection Requirement, 3) ISO0IEC 17025:2017 - General requirements for the competence of testing and calibration laboratories, 4) ISO 14001:2015 - Environmental Management System, 5) AS9110 - Maintenance, Repair, and Overhaul-MRO, 6) ISO 45001:2018 – Occupational Health and Safety Management System, 7) ISO 31000:2018 – Risk Management
Causes	**Effects**
The incoming inspection process in Area Y is carried out according to the needs of the QA department. The inspectors have performed their duties according to standards and procedures by checking that the material-receiving procedures have been carried out properly and in accordance with the requirements.	The QA department has been able to obtain quality materials by conducting early detection on materials to reduce the possibility of producing products that do not meet the requirements. This can also reduce the possibility of disruption to the production process.

Calculation of process effectiveness:

Table 7. Observation of Incoming Inspection Area Y

Indicator	Answer		Total Answers
	Pass	Fail	
Process Control	4	0	4
Measuring and Testing Equipment	3	0	3
Safety and Environment	2	0	2
Foreign Object Damage (FOD)	3	0	3
Special Requirements	1	0	1
Total Productive Maintenance	2	0	2
Total	**15**	**0**	**15**

$$\text{Process Effectiveness} = \frac{\text{Number of "Pass" Answers}}{\text{Total Answers}} \text{x } 100\ \% = \frac{15}{15} \text{x } 100\ \% = 100\ \% \quad (4)$$

The incoming inspection process for area Y shows a 100% effectiveness rate, so it is categorized as an effective criterion. This result shows that the audit items have been carried out well, which means that standards and regulations have been met well and quality control in incoming inspection area Y is running effectively.

Table 8. Advanced Audit Grouping: Final Inspection Area Y

Conditions	Criteria
The final inspection process in area Y at PT XYZ is carried out based on standards and procedures by the QA department. It can be seen	1) AS9100 - Aerospace Quality Management System, 2) AS9102 - Aerospace First Article Inspection Requirement, 3) ANSI/ASQ - Sampling

from the results of the LPA audit that no findings were found during the LPA audit process.	Procedures and Table for Inspection, 4) ISO 14001:2015 - Environmental Management System, 5) AS9110 - Maintenance, Repair, and Overhaul-MRO, 6) ISO 45001:2018 - Occupational Health and Safety Management System, 7) ISO 31000:2018 – Risk Management
Causes	**Effects**
The final inspection process in the Y area has not been carried out in accordance with the requirements of the QA department; the inspectors have not done their job by not updating the skill matrix used and placing the measuring instrument used in the reject area.	The QA department must take corrective action for these findings and close them immediately. These findings can adversely affect quality control, which should be maintained if it follows the standards and guidelines set by PT XYZ. This can cause consumers to be dissatisfied and return the product.

Calculation of process effectiveness:

Table 9. Observation of Final Inspection Area Y

Indicator	Answer		Total Answers
	Pass	Fail	
Process Control	3	1	4
Measuring and Testing Equipment	2	1	3
Safety and Environment	2	0	2
Foreign Object Damage (FOD)	3	0	3
Special Requirements	1	0	1
Total Productive Maintenance	2	0	2
Total	**13**	**2**	**15**

$$\text{Process Effectiveness} = \frac{\text{Number of "Pass" Answers}}{\text{Total Answers}} \text{x } 100\ \% = \frac{13}{15} \text{x } 100\ \% = 86.67\% \quad (5)$$

The final inspection process of area Y shows an effectiveness level of 86.67%, so it is categorized as a fairly effective criterion. This result shows that there is a possibility of a decrease in quality control. Corrective action taken by the quality engineer is to update the skill matrix by entering the name of the new inspector and creating a location to place measuring instruments outside or other than in the reject area.

5. Conclusion

The conclusions of this study refer to the formulation of research problems that have been determined, namely: first, the performance of internal manufacturing audits through the implementation of LPA at PT XYZ is running well and is appropriate. Every month, LPA audits are carried out randomly to cover all work process areas and are carried out by auditors who take turns in each area. Second, the concept of LPA implementation at PT XYZ aims to audit inspectors and work processes in accordance with all specifications and procedures relevant to safety, operational, quality, and customer requirements.

Third, the LPA internal audit has been carried out by comparing criteria, conditions, causes, and effects, which are then given corrective action against the non-conformities found, so in general, LPA as a program of internal manufacturing audit at PT XYZ runs effectively. Fourth, in general, internal manufacturing audits through LPA have generally been running effectively on quality control at PT XYZ. The implementation of LPA in incoming inspection and outgoing inspection in area X and incoming inspection in area Y has been carried out effectively for quality control. However, the final inspection process in Area Y is still fairly effective because there are still some non-conformities.

Implications from the process aspect: this research shows effective results on quality control through the implementation of LPA. From the results aspect, this research can be used as a continuous improvement and optimization of the process, which is expected to help the company through analysis and evaluation of the effectiveness of LPA implementation on quality control.

Research suggestions for developers include conducting a review of audit items to ensure relevance and needs in the work process area of each inspector by identifying statements in accordance with the audited work process procedures. Suggestions for future research are to involve more work processes to assess the effectiveness of LPA on quality control, which is not only limited to the QA department but also involves the production department.

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