The Implementation of an Asset Tracking System for Manufacturing Laboratory Applications

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Abstract *— Globalization and technological advances had made industries to implement systems in which the outcome could be reflected in their competitiveness. Most of the industries incorporates laboratories within their structure to serve as research, developers, design, non-compliance testing and analysis; along with all the work required to perform successful testing and analysis, comes the proper use, maintenance, and record of laboratory equipment or assets. This research intents to improve laboratory efficiency by reducing and eliminating problems/situations caused by the improper record of laboratory assets and lack of team communication. This was achieved using a software called "ProofHub". ProofHub is a useful management tool that provides powerful features offered under one platform. A statistical analysis was performed using Minitab Software to prove that the testing cycle time was reduced with the system implementation; additional outcomes were also achieved such as improved communication, effectiveness, and productivity.*

Key Terms *— Cycle time, Laboratories, Manufacturing industries, Tracking system.*

INTRODUCTION

In the manufacturing industry, it is important to measure components precisely to ensure product/service quality [1]. Working in a manufacturing industry requires compliances with law, regulations, specifications, and more critical parameters to develop a product in conformance with the established requirements. Most of the industries incorporates laboratories within their structure to serve as research, developers, design, non-compliance testing and analysis, calculate aging parameters, among an almost infinite list of tasks that improves manufacturing processes, services, and products. Along with all the work required to perform successful testing and analysis, comes the proper use, maintenance, and record of laboratory equipment or assets. Most of the time, laboratories consist in a significant quantity of equipment which requires constant attention of functionality and performance. An additional task to all laboratory personnel is to keep up equipment information and to share it with all the team members. Sometimes, it is difficult to perform all laboratory work and keep track of assets functionality, calibration due dates, and team communication of these topics and it results in problems and/or situation that could have been avoided.

The intent of this investigation is to develop a tool that helps keep track of lab equipment assets; and relate it to how does a tracking stage reduces equipment problems, testing delays and malfunction prior to maintenance stage. This investigation proposes to reduce and eliminate the problems and/or situations that arise with the lack of team communication and traceability of laboratory equipment. In any manufacturing industry, where time is one of the most important factors to consider for decision making problems, there are many situations caused by improper tracking, operation, and communication of equipment functionality. Among these situations are the following:

- Testing analysis and results completion time are affected.
- Equipment modifications and new components are unknown by lab technician.
- Equipment calibration is due, and asset cannot be used until calibrated.

- Equipment is going to be calibrated or in maintenance in the next days and testing/project will be delayed due to calibration process.
- Equipment was malfunctioning and test results can be compromised.
- Asset is near the last year of service left and replacement has not been issued.

More of the situations highlighted arise in industries due to lack of equipment/asset management and record. When time, productivity, conformance, and earnings are at stake, assessments and action plans must be prepared and planted like the intention of this proposal.

Research Description

This research intents to improve laboratory efficiency by reducing and eliminating problems/situations caused by the improper record of laboratory assets and lack of team communication. Researcher believe any industry will benefit from implementing a laboratory asset tracking system which could be tracked and monitor by each team member of the specific organization. From researcher experience, have witnessed how and why the situations presented in the problem statement occurred; all is due to deficiencies in equipment monitoring and in team communication. The researcher proposes the implementation of a tool that would help into monitoring and communicating laboratory equipment information from and to team members. In a globalized world, where communication and technology are interconnected, it is important to use resources considering use complexity and most importantly the alignment with the desirable outcomes. Selecting a proper tool for the laboratory asset tracking system required various research so the objectives of this proposal could be met. The content of the development of the system includes:

- Tool Selection
- Implementation Requirements
- Proposal Strategy
- User Guide

The overall goal of these research was to reduce and eliminate problems that arise for lacking on an equipment monitoring system between team members of an organization. The expected outcomes of the proposal are determined by the objectives proposed and how they were met by implementing a laboratory equipment system.

Research Objectives

With "The Implementation of an Asset Tracking System for Manufacturing Laboratory Applications" researcher expect to improve laboratory equipment monitoring to promote efficiency. At the same time, enhancing team communication related to equipment tracking and monitoring. The objectives of these proposal are:

- Testing cycle time reduction – This is expected by the implementation of the assets monitoring system which will promote communication and knowledge between laboratory team members and reduce delayed testing.
- Equipment Failure Reduction – This will be achieved due to on-time calibration and equipment maintenance.
- Test Failure Reduction – Due to improved team communication, failure could be avoided with known maintenance dates, requirements and years of asset left.

It is expected to accomplish all the objectives to promote efficiency and effectiveness while acting on a problem that have arisen so many consequences. With the development of the research, it is expected to provide some contributions to the manufacturing industry, specifically the laboratory environment.

Research Contributions

The objective of this research clearly states the contributions that may result from the implementation of an equipment/asset monitoring system. Laboratories will benefit with the development of this research in the following main contributions:

- Test cycle time will be reduced with the reduction of delayed testing due to equipment problems.
- Maintenance tracking and calibrations will decrease the rate of equipment failure.
- Test failure will be minimized with team communication, support, and tracking.
- A more organized workplace will result.
- Improve communication between team members.
- Six Sigma thinking will be promoted.

Among with the main contributions, it will be favorable for the whole industry since additional outcomes like continuous improvement and productivity will result. Both concepts are critical in an era of globalization and technology [2].

METHODOLOGY

The design and implementation of the equipment tracking system is the basis to accomplish the established project objectives. These will be categorized into three project stages following the flow chart presented in Figure 1. The stages represent the structure and design of the equipment tracking system and how it would be implemented.

Figure 1
"The Implementation of an Asset Tracking System for Manufacturing Laboratory Applications" Flow Chart

Management App Selection

After long research, for this project's scope, the selected application (app) to design the proposed model is "ProofHub". ProofHub is a useful management tool that it is easy to use and provides powerful features offered under one platform. It can be easily managed in-office and remote teams from any device, from any location. Advanced features like task management makes it easy for managers and teams to create and assign tasks to team members while setting due dates and estimated time [3]. Group chat and online discussions enable users to quickly start work-related conversations on a single platform [3]. One of the great features are Gantt charts to visualize the important due dates on a timeline and adjust plans as deadlines shifts [3]. The app functionality and tools are summarized next:

- Task lists – Makes easier to manage tasks and can be kept private for individual use or public.
- Tasks – These are selected from the task lists and from the stages they are currently in.
- Gantt Chart – Visual representation of schedule with tasks deadlines and defined dependencies.
- Calendar – View upcoming events and milestones, set recurring tasks and automatic reminders to stan on schedule.
- Subscribers – Task list subscribers who get notified for the activities in the task list and discussions.
- Chat – Team colaboration with one-on-one or group chat option.
- Discussion – Create discussion topics to share ideas or communicate information with team.
- Comment – An option to join the discussion by providing comments and uploading files.
- Files – Upload, organize, and share files.
- Easily provide feedback and collaborate with your team.

After the selection of the tool that would be used to develop the equipment tracking system, comes the next stage which is Asset Distribution.

Asset Distribution

Laboratories often relies in multiple equipment to develop the desire outcomes such as testing specific properties and perform investigations to prove a hypothesis. For this reason, my proposal includes the designation of assets per team member. This option will be better for team members because it would be an all-team job which goes with the purpose of improving team communication and at the same time an equitable workload is provided. An example of the implementation of this stage is provided in Table 1.

Table 1
Team Members Asset Distribution Example

Team Member	Asset Designation
Team Member 1	• Microscope ➢ Z00 Lens ➢ Z20 Lens ➢ Z100 Lens
Team Member 2	• Analytical Balance ➢ Weight Set 1 ➢ Weight Set 2
Team Member 3	• Mechanical Properties Tester ➢ Weight Set ➢ Load Cells

After determining the distribution of the equipment available in the laboratory, it will be discussed how the platform would be used to effectively track the asset data, calibration, and maintenance. A training for the new implementation must be provided. Finally, there is how the developed system will work to accomplish the project's objectives.

Equipment/Asset Tracking System

Once team members have been designated with laboratory assets, starts the implementation of the tracking system. Each team member will be responsible for:

- Coordination of the internal or external calibration.
- Submission of calibration due dates.
- Announcement of equipment changes.
- Announcement of parts changed.
- Maintenance schedules.
- Communication and coordination for equipment malfunction.
- Provide a announcements presentation of the findings and changes to the asset after calibration, maintenance, parts replacement, and/or software updates.
- Upload pertinent files as supportive material.

All these tasks will be accomplished using the platform ProofHub which provides the tools to effectively develop and communicate each stated point. After the last stage of the project, a crucial and most important phase is developed. Data analysis comes now, it is going to be measured the impact of the implementation of the asset tracking system specifically how it affects the testing cycle time. The expected outcome is a cycle time reduction due to the reduction of late testing. A statistical analysis will be performed to prove the stated hypothesis and will be discussed in the results section.

Statistical Analysis

Recorded data will be analyzed using Minitab Software, the analysis will solve the next problem. In a manufacturing plant, laboratory equipment is used to perform Activation Energy Testing to determine product aging conditions. It is supposed that with the new equipment tracking system, the cycle time would be reduced due to a reduction in delayed testing. We want to determine if the cycle time per day is less than 20 hours with an alpha of 5%. The data to be recorded is presented in the Table 2.

Table 2
Recorded Data for Statistical Analysis

Day	Cycle time (hr)
1	20
2	17
3	20
4	17
5	18
6	17
7	20
8	17
9	18
10	18
11	19
12	17

RESULTS AND DISCUSSION

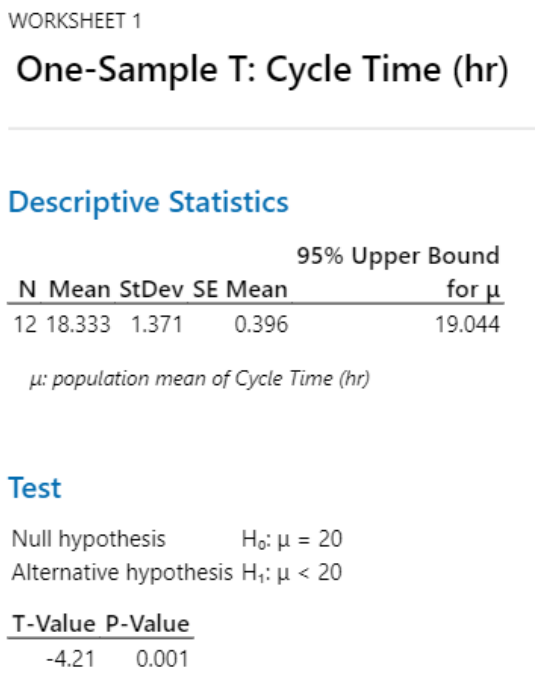
After completing each stage presented the methodology section, the reduction of equipment problems, testing delays and malfunction prior to maintenance were reduced and/or eliminated. These was achieved by implementing an Equipment Tracking System, specifically for laboratories in the manufacturing industries, in which an organize,

remote, and communicative platform was used. The platform was used to share information about assets within all team members, to visualize, track and create awareness of equipment malfunction, calibration, and maintenance and most important to improve peer communication to commit the reduction of testing delays due to situations with the equipment. The management application selected was "ProofHub" which allowed multiple activities needed to perform a functional and reliable system. Each objective, presented in the Introduction section, was satisfactorily completed with the following details:

- Virtual application in which all teammates must access to update the information of the equipment related to their corresponding assests as given in the second stage, Methodology section.
- Completly filled details of each asset activities per month, synchronizing a Gantt Chart for visual tracking of each month of the year.
- Open discussion activity to notify any changes, improvement, part replacement, etc. to all team members.
- Tasks for the month to promote group commitment and accountability.
- Visual Calendar that can be accessed to all team members to be prepared of when and which equipment will not be available and could compromise testing cycle time. The implementation of an action plan will be implemented. Additionally, activities reminders will occur days after the corresponding date and notifications will be via email and platform, both.
- Monthly reports corresponding to the assets of that month developed and uploaded. This report includes, but is not limited to, important dates (ie. calibration, maintenance, replacement, etc.), modified parts, modules, or sensors, software updates, PO associated with the activity implemented, certificates of calibration, years of service left, equipment malfunction, and/or out of calibration.
- Notifications, to all team members, via email and at the platform were available when activities were close to be performed.

Along with the presented results, statistical analysis was performed to determine if testing cycle time could be reduced due to the system implementation (Refer to Figure 2). It was successfully proved that the objectives of the project were accomplished. With the Hypothesis Test results, it was concluded that for t-test, with a resulting p-value of p=0.001; since the p-value resulted lower than the alpha level of 0.05, the null hypothesis is rejected. The alternate hypothesis is accepted, which establishes that the testing cycle time is less than 20 hours per day with 95% confidence level. It is important to understand that the less testing cycle time, the more quickly a team can complete the Activation Energy test for one item.

The following information covers details regarding the body format.


WORKSHEET 1

One-Sample T: Cycle Time (hr)

Descriptive Statistics

N	Mean	StDev	SE Mean	95% Upper Bound for μ
12	18.333	1.371	0.396	19.044

μ: population mean of Cycle Time (hr)

Test

Null hypothesis H_0: μ = 20
Alternative hypothesis H_1: μ < 20

T-Value	P-Value
-4.21	0.001

Figure 2
Hypothesis Test Results using Minitab Software

Additionally, with the monitoring and acknowledgement of each equipment activities there should be a significant reduction in equipment failure. Both achievements complement the

reduction of testing failure due to improved communication on asset activities by all team members and an effective team involvement in all the tasks related to equipment calibration, maintenance, failures, modifications, updates, and much more. It can be easily supported that an equipment tracking system will be a successful and important tool when working in laboratories; at the same time, it promotes a team focused culture in which all people participate, acquire responsibilities, and promotes effective communication for a common good or outcome.

CONCLUSION

Most Important Findings and Limitations

Industrial research has grown throughout the years, and the importance of it relays from selecting the best materials to determine and discover all the hidden factors that determine material behaviors [4]. The purpose of the project was accomplished by developing an Equipment Tracking System in which communication, effectiveness, and productivity would be enhance and promoted. An important task for this implementation was the selection of a platform in which team member activities, discussion boards, and accountability are performed in just one software. Research results has provided a more complete understanding on how the effect of the tracking system will reduce cycle-time, improve communication, and promote continuous improvement. This suggest that laboratories within the manufacturing industry would have a visual organized way to know how laboratory equipment is functioning and/or behaving. However, it is a system that requires teamwork and a culture based on communication, feedback, and team focused. If there is a lack of team focused environment it is important to start working in that matter before implementing the system so it could be easier to adapt and make it work as it should. Companies that have histories of successful plans also have employees who fully understands their roles and responsibilities [5]. A more extensive and developed system could be created as an update not limited to the time frame in which this investigation and project has been performed.

Summary of Contributions

- Manufacturing industries would be impacted and benefit with an implementation of the Equipment Tracking System. Within the contributions provided by the research and project are the following:
- Reduce the cycle time of testing per month.
- Create awareness of equipment functionality, maintenance, and changes.
- Promote a culture focused on teamwork.
- Facilitate calibration information to use action plan when equipment cannot be in use.
- Reduce testing failure.
- Create accountability for team members (lab technicians).
- Track the years of service left for each asset.
- Enhance commitment in the workplace.

The stated contributions are not limited to the ones stated since ach organization will have to overcome their own barriers based on the type of culture they have created and how they want to be to stay productive and competitive.

Future Research

For future research, an upgrade version could be obtained with more research and data for an even better outcome. Additionally, inter-lab and/or intra-lab comparisons could be useful to collect comparative data in which the impact of having or not an Equipment Tracking System could be observed and analyzed. The comparison will lead to improvement areas and to more laboratories adapting this powerful tool. Each organization has their own needs and could adapt the systems performing some modifications that would be useful for the type of industry and work done in each laboratory scenario. By the other side, statistical analysis can be conducted for data sets of testing cycle time per equipment/asset. Since testing cycle time defers from testing and/or equipment used, it is useful and important to obtain

data for each specific equipment and test used/performed.

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