Effective Work Order Requests And Scheduling Tool Design for Maintenance Jobs

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Abstract *— A company located in Puerto Rico, which provides maintenance services and project management for various private properties, identified a problem of delays in maintenance work order response time and completion of requests. It was identified that a tool was needed for effectively planning work order requests and scheduling for maintenance jobs.*

The Plan-Do-Check-Act cycle was used as a Lean methodology tool. In the Plan Phase the Simplex Process was used to identify the problem and present solutions where a Computerized Maintenance Management System was proposed as a possible solution and later was selected as it proved to be a low-cost solution for the high impact in maintenance output. It resulted in a reduction of 52% in work requests by having a system which ensured the best use of time and resources for the company to obtain the quality requested by those who request the work.

Key Terms *— Computerized Maintenance Management System, Maintenance, Plan-Do-Check-Act cycle, Simplex Process*

PROBLEM STATEMENT

A company located in Puerto Rico provides maintenance services and project management for various properties. These properties require high maintenance of superior quality in materials and work, and in most cases, are time sensitive. Work requests and schedules are managed mostly by email, text messages, phone calls and word of mouth. This format creates a non-continuous and, in most cases, unmanageable work rhythm where miscommunication can delay effective job executions.

Research Description

The intention of this research is to identify what is the cause of the non-efficient workflow in the maintenance company. A solution is being sought that can reduce time, reduce work delay and increase quality. It is needed to make tasks more manageable and effective on a regular basis.

Research Objectives

The goal is to create a solution for the maintenance company where job request and work scheduling can be managed in a more effective manner. A study of the causes will help identify the proper process and tools needed to achieve the objective of reducing the amount of open work orders to 50% and complying with scheduled preventive maintenance to an average of 4 days for open requests.

Research Contributions

With the solutions set in place for the work requests, it should:

- Be more streamlined when being placed and organized where it is accessible.
- Follow up work should be easier to manage and perform.
- Time management and job quality should improve and have an increased workflow.
- Operational costs should be lowered by having a better control of time and work that can be performed in less time.
- Customer demands can be met in less time.

THEORETICAL BACKGROUND

Industrial Automation

Industrial automation is the use of control systems, such as computers or robots, and

information technologies for handling different processes and/or machineries in an industry to replace a human being performing manual tasks.

The purpose of automation is to increase productivity (since automated systems can work continuously), and to reduce the cost associated with human operators. It also has the added benefit of increasing quality and flexibility in a process when it is automated.

High Quality

Automation reduces the errors associated with a human being. Unlike human beings, robots and programming do not involve any fatigue, which results in products with consistently uniform quality produced at different times.

High Information Accuracy

Adding automated data collection, can allow the user to collect key production information, improve data accuracy, and reduce your data collection costs. This provides the user with the facts to make the right decisions when it comes to reducing waste and improving your processes.

Industry Acceptance

Industrial automation has recently found more and more acceptance from various industries because of its huge benefits, such as, increased productivity, quality and safety at lower costs.

Plan-Do-Check-Act (PDCA)

Plan-Do-Check-Act (PDCA), or sometimes called the Plan-Do-Study-Act (PDSA), was developed by Dr. William Edwards Deming, a management consultant in the 1950s. PDCA or PDSA is also referred to as the "Deming Wheel" or "Deming Cycle". Deming called it the "Shewhart Cycle", as his model was based on his mentor, Walter Shewhart [1].

PDCA is a four-phase cycle tool for continually improving products, processes, services, and resolving problems. The cycle is performed by testing in a structured system possible solution, analyzing the results obtained, and implementing the ones that provide the best results [2].

The four phases are [3]:

- Plan: the problem or area of opportunity is identified and analyzed. Possible solutions are developed, and it is decided which one to test.
- Do: the potential solution is tested, in a small scale, and the results are measured.
- Check/Study: the result is studied and decided; if it provides the results desired or if alternative solutions are needed to be tested again in the Do phase.
- Act: if the solution is successful, it is implemented.

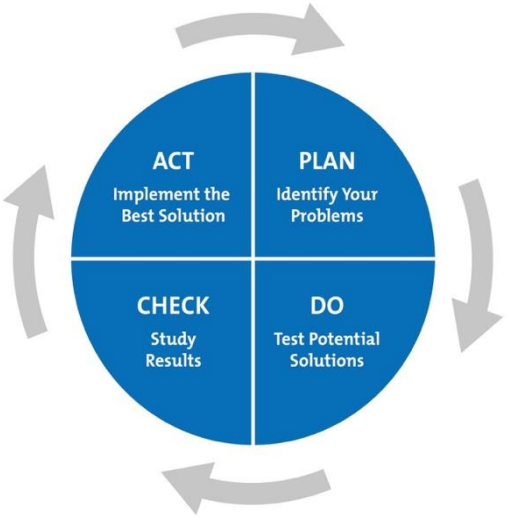

Figure 1
PDCA Cycle Model courtesy of The W. Edwards Deming Institute®.

Do and Check phases can be performed multiple times, testing potential solutions until the best is obtained [1].

The PDCA or PDSA Cycle:

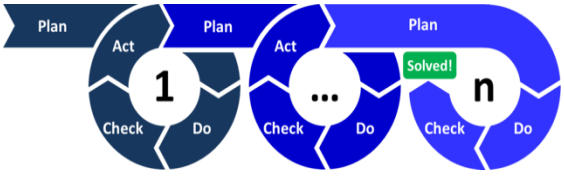

Figure 2
PDCA cycle by Christoph Roser AllAboutLean.com

The PDCA/PDSA cycle is a process loop used for testing improvement or implementation

measures on a small scale before making a final selection on updating a procedure [1].

Steps for PDCA/PDSA

1. Plan

First, the problem source needs to be identified or the opportunity for improvement. In this step, a tool such as the Simplex Process can be used for having a structure in this phase that can help in assessing ideas to develop a plan. The expectations can be quantitively stated at the end of this step to be later used in the Check phase.

2. Do

Once a potential solution is identified, a test with a small-scale test can be done during this step. This will allow to assess whether the proposed changes can provide the expected effect. It should be done in a manner which does not affect normal operation but allow for information to be gathered to assess if the change is effective during the next phase of Check.

3. Check

In this phase, the results of the information gathered in the Do phase are analyzed and measured against the expected results, defined during the Plan phase. With the results, it can be measured if the proposed solution has proven to work or if other tests must be performed. If the results are not acceptable, it is recommended to return to the first step (Plan) to explore alternative solutions and repeat the cycle until the expected results are achieved. If the results are positive, then proceed to the next and final step of the Act phase.

4. Act

If the expected results are achieved, the solution is implemented during this phase. The solution is implemented at a broader scale in the organization. The PDCA/PDSA is a continuous improvement loop cycle, which does not necessarily end at this phase; can be repeated to keep improving on the product or process by using the results obtained as a base for exploring other alternatives or make adjustments that can have greater results and impact on the organization [4].

METHODOLOGY

1. Plan

The problem is to be identified, defined and determined what options are available to develop solutions. Company and maintenance management work using a Simplex Process to determine steps to follow for this phase:

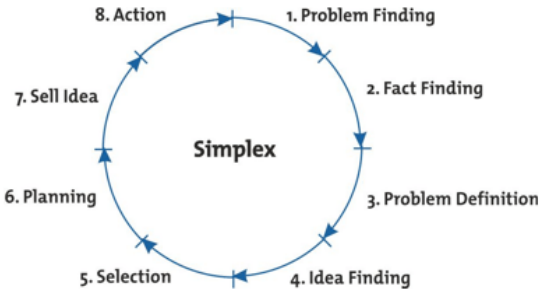

Figure 3
Simplex Cycle [1]

The problem will first be identified, facts about the problem will be pre-determined, and the problem will be defined. Ideas will then be developed and evaluated for later selection of what is considered the best, planning done based on this selection. Finally, the idea will be "sold" to later take action, which in this project transitions into the "Do" Phase.

2. Do

During this phase, the proposed action plan will be tested to establish goal completion dates where sufficient data can be collected on the findings during this period. The data will be used to determine if the strategy used to solve the problem is effective in the next project phase of "Check".

3. Check

After performing tests on the proposed solution and collecting data, it is evaluated to verify if it met the requirements that were being requested as the criteria. If the solution is found to be successful, then the project proceeds to the next phase of "Act". If deviations are observed, the project is returned to the "Plan" phase to evaluate alternative solutions and repeat the cycle until the goal is met.

4. Act

During this phase, it will be assessed any final actions required to complete the goal. If the objective is met, a standard process can be performed, while at the same time, continuously improve the process or software, while the company find a solution to improve the results.

RESULTS AND DISCUSSION

Problem analysis and results using the Plan-Do-Check-Act lean problem-solving Cycle for the improvement of maintenance work order scheduling is presented.

Plan Phase

The company's management noticed that work orders would take an extended amount of time to be completed and, in some instances, would not be performed. After analysis of the cause of delay in work order completion, miscommunication and the absence of an established work order and job scheduling tool accounted for the inconsistent performance.

A project to improve performance and reduce the amount of queued job requests was decided by management to be performed after completing a Simplex Process.

Project strategy: Work requests were compiled into a single location to have a better understanding of the amount work opened, their current status and what would be necessary to complete them.

Data was collected on the amount of time the work requests had been open and priority levels were created according to the needs of the work requestors. More than 100 work requests were documented with open work requests with dates up to one year since being requested.

The data was analyzed to have a clear set of requests of the tool that would be necessary for the maintenance job scheduling.

With the specifications generated, a query was performed to evaluate what options were available in the market as off-the-shelf maintenance software that would meet the following requirements:

- Have the ability to place corrective work orders
- Have the ability to create preventive maintenance work orders
- The software should be capable of pushing notifications
- It should be able of allowing users to view historical data of work orders on demand
- Be able to sort data by location, work type, employee, date and priority
- Give users the ability to include pictures and notes when creating work requests
- Have multiple levels of users and security as administrators, workers and requesters
- Be accessible, remotely or on mobile devices, to not limit or require the addition of specialized hardware.

Cost of the program was not a priority during the evaluation of options available in the market. When determining the top contenders for the comparisons these were chosen with online review information available while also performing a verification of the legitimacy of the recommended software developers. The ones which had most positive feedback, including customer service, were selected.

Preventive Maintenance Management System comparison

Scale used 0-5 to value requirement being met. I.e.: "0" does not meet requirement, "5" requirement met fully, "1 - 4" partially meets requirement.

Requirements	*Facilities Management Express*	*Maintenance Connection*	*UpKeep*
Have the ability to place corrective work orders	5	5	5
Have the ability to create preventive maintenance work orders	5	5	5
The software should be capable of pushing notifications	0	3	5
It should be able of allowing users to view historical data of work orders	3	3	4
Be able to sort data by location, work type, employee, date and priority	4	4	5
Give users the ability to include pictures and notes when creating work requests	2	2	3
Have multiple levels of users and security as; administrators, workers and requester	5	5	5
Be accessible remotely or on mobile devices to not limit or require the addition of specialized hardware	3	1	5
TOTAL	27	28	37

Figure 4
Preventive Maintenance Management System comparison chart [5][6][7]

Do Phase

After defining that the Preventive Maintenance Scheduling software would be obtained from UpKeep, being off-the-shelf software, it would need to be set up and have settings adjusted

accordingly to the operations needed from this company. A trial period of one month would allow for the software to be tested and any concerns to be cleared before purchasing it, allowing its practicality to be measured.

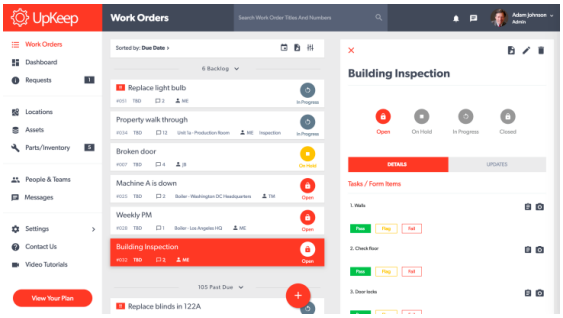

Figure 5
UpKeep Program Work Order Screen [7]

Data was uploaded with all the current open work requests to the platform. A program manager was established with administrator permissions which would have the authorization of making changes to work orders, add users, modify user privileges and assist in any technical issues that could be managed from an administrator role.

An automated preventive maintenance schedule was developed with the historical data provided by supervisors and the manager. The data included items which would need regular preventative maintenance such as HVAC equipment, paint, cleaning and inspection.

With the historical data, it was also observed that predictive data would be needed for items which required a regular inspection routine to prevent faults which could be caused from improper maintenance; for example gates, doors, windows, filters and equipment exposed to elements such as sun, rain, salt, and wear and tear.

Check Phase

After performing tests on the software from UpKeep for maintenance management during the trial period of one month, it met the requirements that were being requested as the criteria. It also proved to be user friendly for people of different levels of technology expertise.

The software allows to be used on mobile devices. Technicians and admins can verify work requests from requesters, following up on already set job orders and automatically created preventive maintenance job orders.

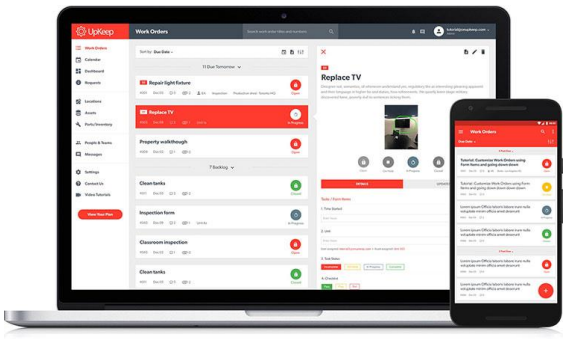

Figure 6
UpKeep Program Desktop and Mobile Application Work Order Screens [7]

It also has the ability of displaying a calendar where it is easier to see the scheduled preventive and corrective maintenance jobs requested, in blocks of time, separated for specific jobs, with the added benefit of seeing upcoming due dates and jobs by priority if necessary.

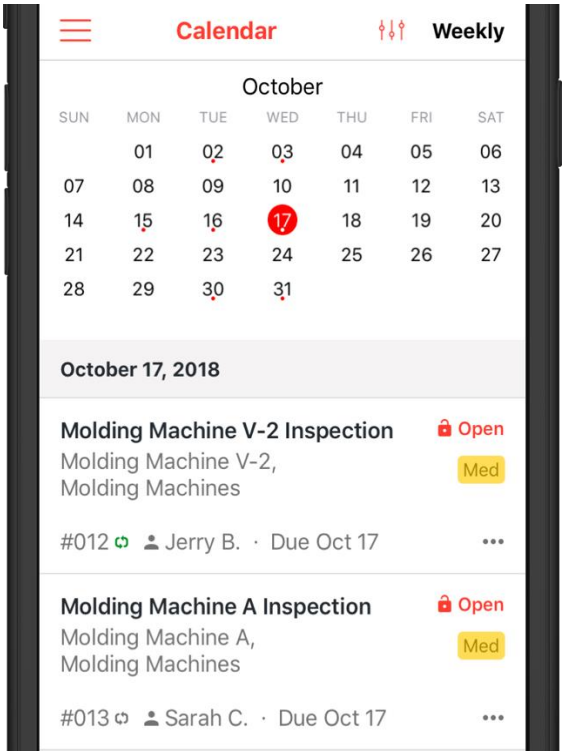

Figure 7
UpKeep Program Calendar with Scheduled Work Orders [7]

Act Phase

After a successful trial period of one month and a following two months of continuous testing and use, with the benefits obtained, UpKeep software has been decided to be the approved software to be officially used in the company by its personnel.

It met the required criteria and for the size of the company because the cost of under $350 dollars was well accepted by management, as it is considered a low investment for the productivity obtained, by reducing the amount of 113 work requests, many past due, to 54 open requests in the three months since the program testing begun. Follow up training was provided to the employees working directly with the program to further expand expertise on work order management.

CONCLUSION

The PDCA Cycle provides flexible problem-solving strategies which proved effective for this project. It is a tool that can and, in most cases, is unconsciously used in problem solving as it requires identifying the problem (Plan), having ideas of strategies to resolve the problem (Do), testing the best ideas and if it proves to be effective (Check), continue improving on the solution (Act) or otherwise returning to the planning phase.

With the use of this lean problem-solving cycle, the 113 corrective maintenance requests were reduced by 52% to 54 in three months. The advantage of having the software allowed team members to access and manage work orders in an organized manner, while providing updates almost instantly. The system kept other team members informed on the statuses, allowing for other tasks to be done simultaneously and effectively. With historical data being analyzed, it also allowed for predictive measures to be implemented and preventive maintenance to be modified to ensure proper maintenance and life longevity on equipment and hardware, which required to be increased or decreased according to each need.

With the implementation of the software, it has been considered a low-cost solution for the high impact it has produced. The adjusted maintenance schedules ensure the best use of time and resources for the company to obtain the quality requested by those who request the work.

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