# How a Reactive Inventory can be Improved with a Computerized Work Tool

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## Abstract

An effective inventory management and reagent tracking control enable the company to reduce cost, save time, and reduce waste, while increasing productivity and business efficiency. It is proposed to create an inventory management tool that helps the continuous monitoring of the reagent inventory in a service analytical laboratory. The project proposes to implement a tool that allows analysts to continuously identify the laboratory inventory and the tracking of reagents within the laboratory. It will be a user-friendly tool, which will maintain an organized laboratory environment, in order to increase analyst performance, and eliminate test delays due to lack of reagents or additional charges in orders. The tool will give useful information to the analyst about where the reagent is or who has the reagent within the work area, but it will also alert the administrator when the reagent is about to run out or is close to its expiration date.

## Introduction

The management and control of the reagent inventory and the tracking of its use is essential to avoid loss of time and money. Maintaining a continuous inventory monitoring sustains the correct balance between what we have, what we need and how it flows within the laboratory, hence creating these tools is essential for keeping control. The purpose of the proposed research project is to implement a computerized tool in order to reduce time loss within small laboratories dedicated to analytical testing. The laboratory measure monthly their employee productivity, which has remained at an average of 95% before the tool implementation. The design of the research project will seek to resolve those factors that affect employee performance, in order to reduce loss. Low productivity in employees, is not the only consequence of the lack of control in the inventory, the problem also causes delays on the delivery of customer results, or loss of product due to poor planning. Poor inventory with excess of reagents can lead to a loss of products due to expiration.

## Background

Previous research has shown that poor organization and poor planning of inventory within service organizations can affect business finances considerably. Investigations have been able to conclude that many laboratories dedicated to the analytical testing service, lack control over their inventories. Therefore, in order to support the organization and reduce expenses, it is substantial that companies implement systems for the inventory management. The implementation of computerized systems capable of keeping inventory under control will provide economic improvements to any organization. The developed tool worked as an inventory management system, in which the analyst could know the complete status of each reagent, where it was located, if it was in use, who was using it, how much reagent was available, or if it was necessary to purchase the reagent. Inventory management, including control, flow and use, was key to improving business profitability. The implementation of technology has contributed to improving inventory movement within small businesses, resulting in competent inventory management, improving costs, reducing time loss and increasing the performance of its employees.

## Problem

Each organization aims to have an organized work environment that facilitates the performance of the employee and thus avoid waste that affects their finances. The ideal scenario for any organization would be to avoid wasted time and keeping an inventory in order to better track and control the organization. There are conditions that make it difficult for these objectives to be reached, since there are no easy-to-use tools that can make it simpler for the employee to identify the flow of each item when they perform their work. For laboratories it is essential to avoid wasting time when performing tests due to the lack of organization. In such organizations, there are determined areas of storage, but many times the reagents are currently in use and that is where problems arise, since the analyst would have to look at what areas the reagent is located or who may be using it.

The research project proposes to implement a computerized tool in order to solve those factors that affect the performance of employees and avoid waste that affects the company profitability. The tool will allow the analyst to identify the flow of reagents within small analytical laboratories, thus maintaining continuous monitoring of the reagent inventory.

## Methodology

Each analyst within the laboratory has individual tasks, therefore standardizing cycles times or certain tasks in the laboratory is not a real option. After reviewing the literature, it was established that the use of validated inventory systems would not help to resolve the factors that influenced the poor performance of employees within the laboratory. The limiting factors with the greatest influence on decreasing the analyst's performance were not finding the reagent in its place and reagent expired or completely consumed. To have a cycle time with added value, inefficiency in the time to perform the task of searching reagents had to be reduced.

The inventory system will be developed so that it can track the daily consumption of each reagent, alerting the inventory custodian when a reagent is about to expire or be completely consumed. The tool will be easy to use, which does not increase the waste time of the analyst. At the same time, the system must be able to track reagent movements through the laboratory, so that the analyst knows where the reagent is and who uses it.

To comply with the performance levels established by the company, each employee must complete:



To optimize the workflow, the cycle time was estimated, to establish the approximate time that the analyst took to acquire the reagents necessary to perform the test. To estimate the time, a worst-case scenario was chosen, the test that had the greatest number of reagents was selected. Then, proceeded to measure the total time took for each analyst to complete the reagent search task.
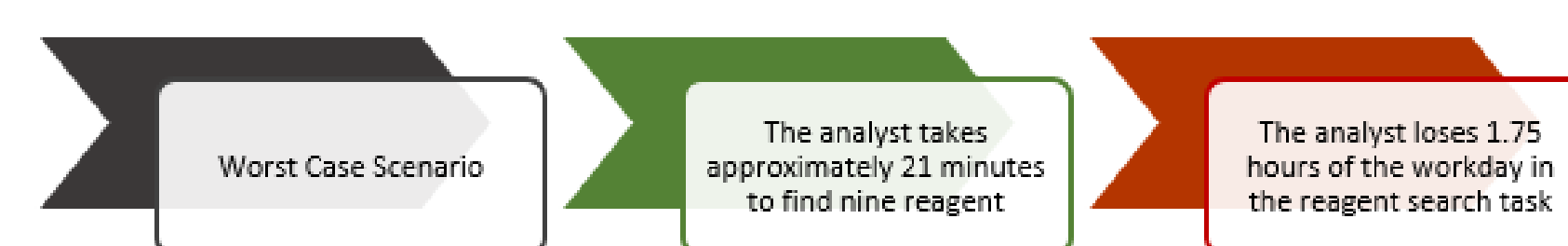


The proposed tool will be implemented utilizing Visual Basic for Applications (VBA), which is an implementation of Microsoft's programming language Visual Basic that is built into most Microsoft Office applications, specifically to this project, in Excel. This combination of Excel as a database and VBA user defined functions and forms will enable the analyst to monitor the tracking of the reagents within the laboratory in a more structured manner. The tool will consist of two sheets: Use Sheet (table 1) and Inventory Sheet (table 2).

### Table 1
### Use Sheet

| Reservation ID | CAS # | Reagent | Analyst Name | Date of Use | Return Date or Finished Reagent | Quantity Used | Name of the Test |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

### Table 2
### Inventory Sheet

| Reservation ID | CAS # | Reagent | Receiving Date | Quantity of Reagent | Expiration Date | Location | Manufacturer |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

Both sheets' primary function is to work as a database, in which all required data will be stored in their belonging table and cells. The Inventory Sheet will store information as the Reagent name, their Chemical Abstract Service (CAS) registry number, manufacturer, quantity of the reagent package, where will be stored within the laboratory, expiration date and the date of when it was received. The Use Sheet will work mostly as a journal to track the information of how the reagent is used in the laboratory. The required data for the Use Sheet is the CAS registry number, the reagent name, the name of the analyst which will be using the reagent, date of use, quantity used, name of the test the reagent is going to be used and the date the reagent was returned to its location. Additionally, there will be a third sheet with a Menu form, in which the user would be able to add new reagents, reserve reagents to be used in tests and search reagents currently on the inventory.

## Results and Discussion

A computerized inventory tool was developed to establish an appropriate method as part of inventory management and to solve the problem of reagent tracking within the laboratory. The first approach was to establish a design of the menu windows and the information that will compose each spreadsheet in the tool. The feedback of the analysts, the literary reviewed and the observation of the behavior of the inventory within the laboratory were used to establish the design of the tool.
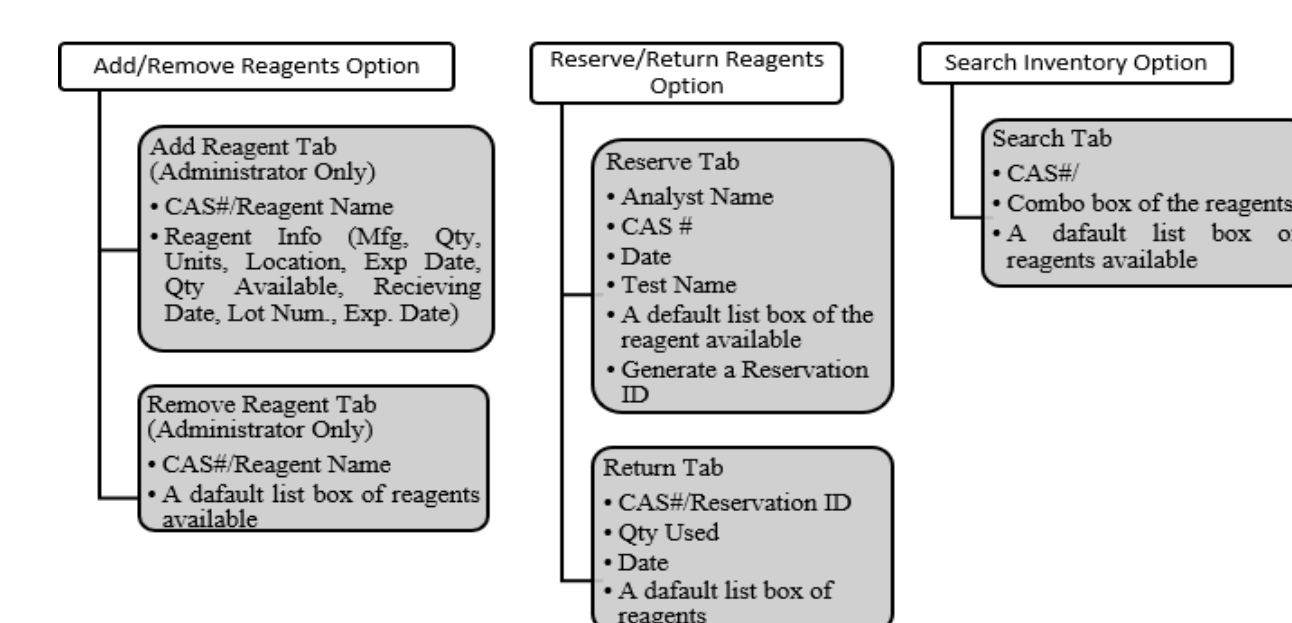


The results obtained in the project; we can observe that the implementation of the inventory management system provides a structured control of the tracking of the reagents. The tool controlling the inventory of reagents, the inputs and the outputs of the inventory area, the movements of the reagents through the laboratory and the available quantities of the reagents. In addition, the inventory tool provides feedback about the reagents that need to be purchased, avoiding excess of inventory and unnecessary purchases; the laboratory will only purchase what it is necessary.

As part of the strategies to improve performance in the workplace and improve the profitability of the company, the laboratory, where the tool was implemented, assesses the productivity of the employees daily. This company generated metrics that were used as a reference to determine whether the inclusion of a computerized inventory system could add value to the laboratory. These statistics gives the company a guide on how and where they can improve. As was mentioned in the Methodology section, to comply with the performance levels established by the company, each analyst must complete a minimum of five daily tests in eight hours of work. In addition to this, $\leq 4$ hours of overtime in general would be accepted. The productivity of the employees was measured for three months, February to April, during these months the productivity of the employees increased by 2%. Minitab was used to confirm the impact of the computerized tool on the employee productivity. The P value obtained in the statistical analysis was 0.000 which is less than the 0.05 level of significance, with a 95% confidence value, which indicates that our results are statistically significant. The results conclude that the impact on productivity was approximately 2%.



The metric for the on-time delivery must comply with the $\geq 95\%$ test on time posted 2 days before due. Laboratories dedicated to the analytical testing service debit profits by delivered results and documentation to their clients. Therefore, we will take as a reference the delivery metrics to conclude, the profitability of the company. The delivery metric is assessed daily by the company, for the project the delivery was measured for three months, February to April. After the implementation of the tool, the delivery of the company remained in compliance, thus sustaining the profitability of the company.
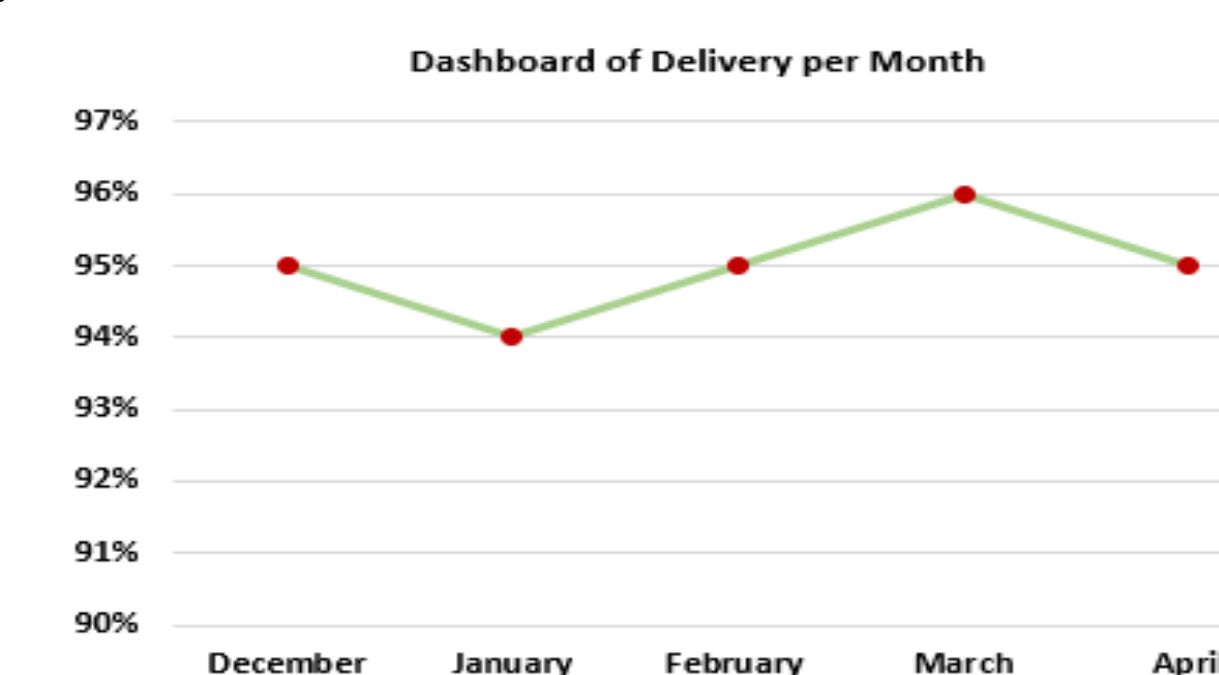


## Conclusions

Inventory management systems are essential tools for a laboratory to achieve its objectives of maintaining an appropriate and organized work environment and contributes to reducing waste. The implementation of the computerized tool proposed demonstrated its effectiveness; the developed method was a solution to the problem for the continuous monitoring of the reagent inventory throughout the laboratory.

Contributions:
- A user-friendly tool was developed, which allowed the laboratory to be dedicated to analytical tests to improve the control and organization of its inventory.
- One of the most remarkable characteristics of the tool it is its simplicity, decreasing implementation and training costs.
- The inventory management system managed to correlate inventory control, reagent tracking, and future purchases in a general and simple method.
- The implementation of the tool offers a standard process that minimizes the loss of time and avoids excess inventory.
- The project increased the capacity of the laboratory, offering a complete information of the available reagents and eliminated the problems of the reagents in use. With the tool, the analysts know the location of the reagent, laboratory capacity was increased by 19.6% in three months.
- The control panel sheet added to the management system could reduce additional charges for urgent orders or the delay of tests due to lack of reagents.

## Future Work

This data will be useful to maintain an inventory control in order to satisfy the demand for reagents of the company. The data collected by the tool can be analyzed to estimate the use of each reagent in a determined period, for example quarterly, this would make it possible to estimate the demand for reagents in that specific period. This estimate will ensure that the correct demand is maintained, as well as avoiding last minute purchases, delays in testing and maintaining high levels of quality in the laboratory.

## Acknowledgements

## References

- S. Spitzer, R. Lee-Huang and S. Dhana, "Efficient inventory control in the laboratory," American Journal of Clinical Pathology, vol. 149, issue suppl_1, p. 24, January 11, 2018. [Online]. doi: 10.1093/ajcp/aqx116.054
- S. Delgado Soto, L. Cruz Rivero and E. Lince Olguín, "El uso de software libre en el control de inventarios: caso de estudio," Ciencia Administrativa, no. 1, pp. 52-57, July 12, 2019. [Online]. Available: https://www.uv.mx/iiesca/files/2019/10/08CA201901.pdf
- M. K. Payne, A. W. Nelson, W. R. Humphrey and C. M. Straut, "The chemical management system (CMS): A useful tool for inventory management," Journal of Chemical Education, February 20, 2020. [Online]. Available: https://pubs.acs.org/doi/10.1021/acs.jchemed.9b00905
- J. R. Revollar Ramos, "Aplicación de Gestión de Inventario para mejorar la productividad en el área de almacén de la empresa Industria Química Mendoza e Hijos," B. S. thesis, Professional School of Industrial Engineering, César Vallejo University, Lima, Perú, 2019. [Online]. Available: http://repositorio.ucv.edu.pe/bitstream/handle/20.500.12692/37041/Revollar_%20R%20J%20R.pdf?sequence=1&isAllowed=y
- M. A. Ríos Cárdenas, "Aplicación de la Gestión de Inventarios para la mejora de la productividad en el área de almacén de la Empresa Pesquera," B. S. thesis, Professional School of Industrial Engineering, César Vallejo University, Lima, Perú, 2017. [Online]. Available: http://repositorio.ucv.edu.pe/bitstream/handle/20.500.12692/13671/R%c3%ados_CMA.pdf?sequence=1&isAllowed=y
- D. Miller, S. Schultz, G. Robertson, J. Bodiya and S. Caglioti, "Development of a reagent/supply Inventory Control Management System," Transfusion, vol. 41, no. 9, p. 136S, January 2001.
- D. Lowe, "Keeping track of all those chemicals," Science Translational Medicine, October 22, 2010. [Online]. Available: https://blogs.sciencemag.org/pipeline/archives/2010/10/22/keeping_track_of_all_those_chemicals