IMPACT OF LABORATORY AUTOMATION AND INFORMATICS AT MUFULIRA ANALYTICAL LABORATORIES

C. Mulenga, K. Nyirenda, M. Songolo, Y. R. Hara [d], J. Banda[e]

The Copperbelt University, School of Mines and Mineral Sciences, P.O. Box. 21692, Kitwe, Zambia

Email:chamamule@gmail.com

ABSTRACT

Mopani Copper Mines has been experiencing late process of result reporting at its Analytical Laboratory. The delay in reporting results has been attributed to increased number of samples and analyses that are required within standard laboratory practices. Because Analytical Laboratories desire to enhance their performance as a way of increasing operational capacity, reduce operational costs, and improve cash flow, technological trends which elevate experimental data quality and reduce laboratory turnaround times were adapted at Mufulira Analytical Services Department. The study was undertaken to assess the impact of laboratory automation and informatics on the cost of operations, production output and quality of operations. Primary and secondary data was collected and analysed on a sample population size that included employees from the Analytical Services Department and client departments.

The research study made the following conclusions:

(i) Automation and Informatics has resulted in improvement on the performance of operations of analytical laboratory, with the increase of 5.03 per cent on the number of samples analysed, cumulating to 1,344 number of samples in reference to the months of July and August in the base year of 2013.

(ii) There was a reduction in costs as a result of automation and informatics as evidenced on savings of 32.83 per cent on overtime hours, which cumulated to 1,331.34 hours saved, with reference to the base year 2013.

(iii) Automation and informatics has resulted in reduction of errors and an improvement in the performance quality of the analytical laboratory.

(iv) Post-automation and informatics was better than pre-automation and informatics.

In order to reduce costs, increase cash flow and improve performance, the study recommended that Mufulira Analytical Services Department should scale up automation of its laboratory processes.

Keywords: *Automation, informatics, laboratory, analyses.*

INTRODUCTION

The Analytical Services Department (ASD) at Mopani Copper Mine site plays a key role as it provides analytical services to the production, process and service departments. The Department handles samples collected from the various designated points in the production and process plants at different frequencies which are brought for analyses. The sources of these samples include mining, concentrator, smelter and refinery and demand for timely analyses, accurate and quality results that are required for the purposes of critical process control, plant accounting, exploration and process development. Considering that every Analytical Laboratory desires to enhance its performance, in terms of decreased operational costs, increased operational capacity and improved cash flow (Paul 2016), the Analytical Services Department at Mopani is no exception in this quest.

In 2009, Mopani Copper Mines successfully commissioned the ISA-smelt upgrade project, in its second phase, two new bigger anode furnaces and twin anode casting wheels at cost of US$81 million. With the completion of phases one and two, there was an improvement in the Smelter capacity to about 625,000 tonnes per annum, concentrate treatment from 420,000 tonnes per annum, whilst sulphur capture improved to 51 per cent at Mufulira smelter (Musenge, 2014). This led to an influx of samples being received at both smelter analytical satellite laboratory and the main Mufulira Analytical Laboratory that require rapid, accurate and precise analyses within the shortest turnaround time. Thus the main objective of this study was to assess the impact of Laboratory Automation and Informatics on the performance of Analytical Laboratories, in terms of decreased operational costs, increased operational capacity and improved cash flow.

A Review of Laboratory Automation and Informatics

Laboratory Automation

Laboratory automation refers to the use of technology to streamline or substitute manual manipulation of equipment and processes (Trigg, 2012). With most workloads of the analytical laboratory being manual, it is clear that majority of analyses are repetitive and routine in nature. Hence, from the onset of sampling through to the point of result reporting the process tends to be tedious and time consuming, thereby leading to delayed process times in result reporting required for critical process control aspects. Therefore, the need to automate certain processes becomes critical. The laboratory automation process has continued to evolve and is becoming increasingly sophisticated and complex. It is a diverse-system, where seldom clones as dictated by the specific needs of various laboratories. Its interdependent-systems must interface with electronic and mechanical components, other systems, and with human beings. Management has the responsibility to provide these alternatives when they exist and

also the mandate to develop additional alternatives if at all possible (Thomas, 1995). Hence with this, automation can be thought of as the process of allocating activities or duties to a machine or system, which have been performed by humans in the recent past, with the aim of reducing errors, improving turnaround times for result reporting and simplifying workloads.

Benefits of Laboratory Automation

Robotic workstations have advantages over manual liquid handling since robots can work without fatigue, increase the throughput, perform consistently, and ensure accuracy and precision. There is such a huge difference in the scale and scope of automation for robotic liquid dispensing (Kong *et al.,* 2012). The laboratory interacts with its customers during sample processing, analysis and storage These are critical components for effective customer satisfaction. Improvements in the analytical laboratory workflow and the timeliness and accuracy of results reporting will not only benefit the laboratory but can also translate into increased output and client satisfaction with laboratory services. Therefore, laboratory automation can be viewed as the most popular option to improve internal and external laboratory services for both the employees at Mufulira Analytical Services and their client departments. It is evidently clear that automation can offer a variety of benefits, including improvements in analytical processing efficiency and errors, answers to labour shortages, and potential revenue generation. The improvements in laboratory operations can translate into better laboratory services, improved laboratory operations, and an increased client department satisfaction. Automation has many benefits. Nelson (1969), pointed automation into the laboratory as having important benefits. These included an increased speed of test performance, acceleration in the rate of production of reports, and increased productivity in terms of the number of tests which could be carried out per technician per year. As a consequence, this reduces labour costs, leading to a diminution in the cost per test. There is considerable evidence that the accuracy of the results performed in larger automated laboratories is better than those performed in smaller laboratories. There is also increased saving in technical time so that it becomes possible to extend the range of laboratory tests in analysis of samples. Therefore, these highlighted points were critical in this research study.

Laboratory Informatics

Laboratory informatics refers to the application of information technology to the handling of laboratory data and information (Trigg, 2012). Laboratory Information Management Systems (LIMS) are applications used to track, manage and report the information used and generated in the laboratory (Walford, 2000). This is vital in laboratory operations and in critical process control in plant operations.

Benefits and Disadvantages of Laboratory Informatics

The benefits that can accrue to a laboratory when using a LIMS include: (a) Less result entry error, (b) increased productivity, (c) better cost control, and (d) faster turnaround time.

The disadvantages include (a) software costs are only a fraction of the expense in installing LIMS, (b) the need for a LIMS "champion" in the organisation, (c) some form of information technology support, (d) only structured reports are allowed.

Tagger (2016), points out some of the benefits of laboratory informatics i.e. laboratory information management system to the operations of a laboratory as in information being obtained at the click of a button without digging through files, years of data can be kept easily without the need for traditional archiving, improvement of business efficiency, improvement of data quality (as all the instruments are integrated), automated log-in, sample tracking management and automated customer reports. Masuku and Seeripat (2007), also highlight eight benefits that laboratory automation management system has on analytical laboratories, in terms of sample tracking, sample security, data security, improved laboratory efficiency, ease of improvement, process improvement, visual workflows and reporting. Jarolim (2008), echoes these benefits of automation in the pre-analytical, analytical, and post-analytical phases of processing and includes a safer workplace for employees, decreased errors, more consistent turnaround times, increased productivity, and enhanced flexibility for resource reallocation.

With such great benefits pointed out, it is evidently clear that the advantages of laboratory automation and informatics out-weigh the disadvantages, thus laboratories would surely increase their operational efficiency through improved TAT, reduction in cost, increased sample handling and lead to satisfied work force, as all aspects critical in facilitating laboratory operations would be integrated.

The Impact of Laboratory Automation and Informatics at Mufulira Analytical Services

Mufulira Analytical Services Department (ASD) is divided in three sections, namely; Classical section, Plant control section and Instrumental section. The classical section is responsible for sampling and sample processing route in the laboratory. Different sample types ranging from mining grabs and geological drill holes, process slurry samples from concentrator, concentrates, metal scrap, cathodes, anodes and slimes are received and prepared differently according to particular procedures stipulated. Water samples and other liquid samples like oil and electrolytes do not undergo any preparation, but are all received at classical section.

The plant control section has the mandate on the following operations:

(i) ISA-smelt laboratory handling smelter samples, environmental samples, fire assay analysis and the analysis of oil samples from the engineering department and the responsibility of results reporting for these samples.

(ii) The instrumental section has the mandate for analysis of routine and non-routine samples. This section covers routine analysis of mining grabs and geological drill holes, third party Concentrates, Concentrator shift composites (Coarse heads, wet heads and concentrates), Tank-house electrolyte dailies, Waters and Tank-house electrolyte titrations and non-routines (Metallic, copper matte, scrap, toll material, inter laboratory exchanges). It is also the role of this section to report results of routine and non-routine samples after analysis.

As a result of all these quantity of samples and many more, massive pressure is the order of the day at Mufulira analytical department, as demand of rapid analyses, accurate and precise results, is urgently required for the purpose of critical process control and plant accounting.

Exploratory, descriptive and quantitative (use of two tail kind of test in analysis) research design was used in this study. This was because it tends to give background information about the general impact of automation and informatics in enhancing performance of analytical laboratories.

The research study population included employees from analytical services department and client departments. Employees from analytical services department were further divided in classes of input (sample preparation and analyses), monitoring (analyses) and authorising (laboratory top management). This was done so as to take an in-depth of information, pertaining to the impact laboratory automation and informatics had, on the performance of analytical laboratories and how its clients are utilising the services. Further, operational costs and operational capacity data was obtained from analytical monthly performance reports in relation to the level of automation and informatics on critical processes, which are yet to be fully explored.

RESULTS

Figures 1 to 3 and Tables 1 and 2 show the results of performance on cost of operations in the pre- and post-automation and informatics.

. **Figure 1**: **Pre-automation and Informatics Performance on Cost**

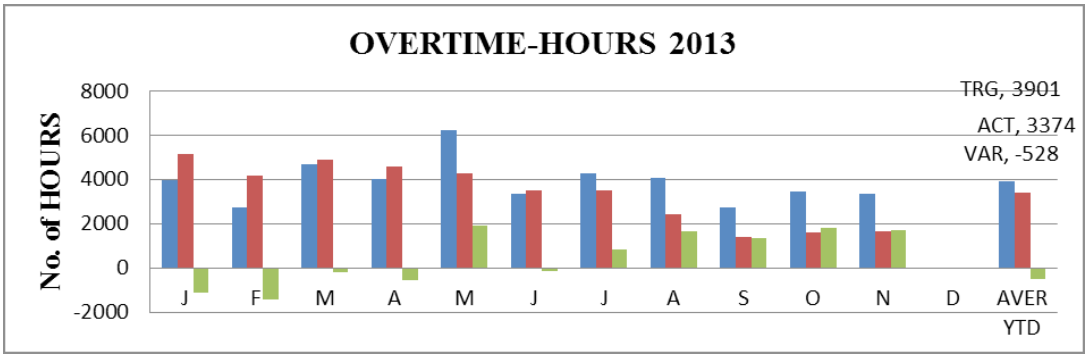


Table 1: **Summary of results on Cost pre-automation and informatics**

Overtime t - Test: Paired Two Sample for Means 2013		
Quantitative Statistics	**Target**	**Actual**
Mean	4172	4055.25
Observations	8	8
df	7	7
P(T<=t) two-tail	0.797	
t Critical two-tail	2.365	

Figure 2: **Post-automation and Informatics Performance on Cost.**

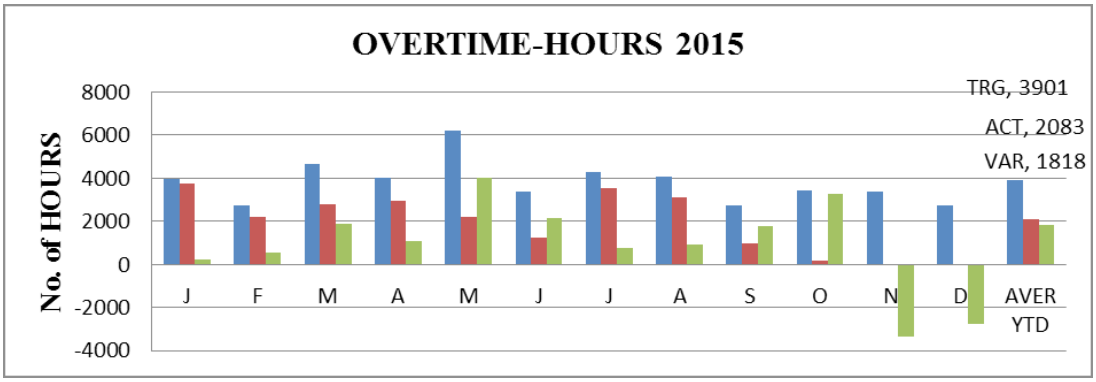
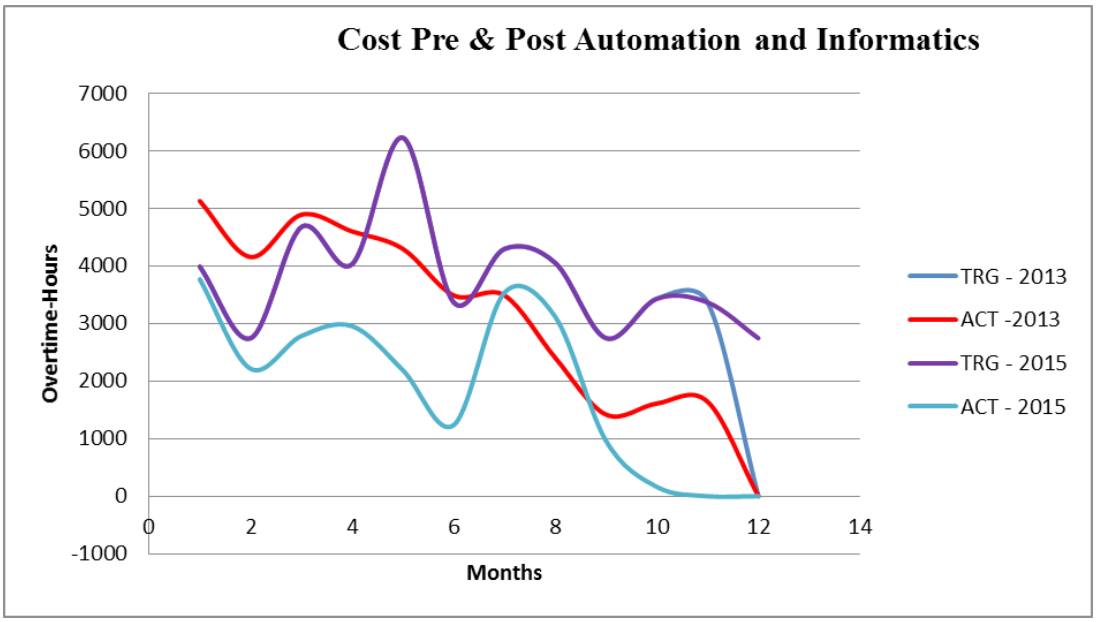


Table 2: **Summary of results on Cost post-automation and informatics**

Overtime t - Test: Paired Two Sample for Means 2015		
Quantitative Statistics	**Target**	**Actual**
Mean	4172	2724
Observations	8	8
df	7	7
P(T<=t) two-tail	0.013	
t Critical two-tail	2.365	

Figure 3: Comparison on Pre and Post-automation and Informatics performance on cost.



DISCUSSION

The results obtained on cost of operations in terms of overtime hours, clearly showed automation and informatics had a positive impact in the cost of operations on analytical laboratory. This is evident from statistical summary Tables 1, 2 and Figure 1, 2 and 3 which showed the summary performance on cost of operations, with reference to the base year 2013 performance (pre-automation) and the 2015 performance (post-automation), in the first eight months. Cost of operations in terms of overtime hours drastically reduced between pre-automation and post-automation for the mean value for the first eight months for pre-automation was 4,055.25 hours against the target of 4,172 hours. Although this was lower than the set target on overtime hours, it is evident

that post automation and informatics performed very well on overtime hours spent as its mean value was 2,724 against the set target of 4,172. Laboratory automation and informatics had a positive impact on cost of operations, as seen on the saving of 32.83 per cent on overtime hours, which cumulated to 1,331.34 hours saved, with reference to the base year 2013, hence leading to a positive return on the department.

CONCLUSION

From the findings and analysis of the study, the following conclusions have been deduced:

1. Automation and Informatics has resulted in improvement on the performance of operations of analytical laboratory. The increase of 5.03 per cent on the number of samples analysed, cumulating to 1,344 number of samples in reference to the months of July and August in the base year of 2013 was recorded.
2. There is a reduction in costs as a result of automation and informatics. Savings of 32.83 per cent have been recorded on overtime and accumulated to 1,331.34 hours with reference to 2013 as the base year.
3. Automation and informatics has resulted in reduction of errors and an improvement in the performance quality of the analytical laboratory.
4. Post-automation and informatics was better than pre-automation and informatics.
5. In order to reduce costs, increase cash flow and improve performance, the study recommended that Mufulira Analytical Services Department should scale up automation of its laboratory processes.

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