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An Open-Source Application for Clinical Laboratories Using R Programming Language

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Abstract

Clinical laboratories must thrive using supportive analytical tools to maintain the cost control and profitability during economic uncertainty, the shortages of laboratorians, and public healthcare emergencies like the COVID-19 pandemic. R Programming is a comprehensive open-source and platform-independent tool that can manage large datasets and display key performance indicators through real-time dashboards. This study seeks to innovate the performance excellence framework of small-sized clinical laboratories located in the India, using R Programming's Shiny App dashboard. It will also encourage small-sized clinical laboratories to transition into a next-generation enterprise by digitizing their decision-making tools and improve performance using data analytics.

Keywords: *-R Programming, Clinical Laboratory, Performance Excellence, Shiny App, Healthcare Information Systems*

INTRODUCTION

Clinical laboratory services are indispensable in the communities for testing and supporting the healthcare system nationwide. One of the significant challenges that clinical laboratories face today is the need for "doing more with less," so laboratorians must process an increasing volume of tests with the same instruments and personnel. Currently, clinical laboratories are being impacted by the economic downturn and recent

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pandemic of COVID-19 since December 2019. Other factors causing devastation in the sector are the decrease of investments, difficulties in enhancing global trade supplies, the massive unemployment, and the bankruptcy of companies dramatically.

Small-sized clinical laboratories have lacked the space and budget required for automating instruments and data flow. An innovation of operational models can occur by introducing a real-time statistical tool for decision-making to monitor the laboratory value chain. Using the competitive advantage of R programming language and open-source nature, this study presents a data analytic tool and prototype to support the performance excellence framework of small-sized and stand-alone laboratories in the nation.

This tool was developed using the R programming language and its Shiny App open-source package that can display real-time data and indicators of the performance excellence of clinical laboratory departments and the productivity of the laboratory's workflow. The present research will emphasize the strength of introducing data analytics through an open-source dashboard prototype into the daily management of small-sized clinical laboratories to progress in automation and leverage the uncertain environment impacting them from offering an efficient healthcare service to the public.Appropriate style is still applied to each section, reapplying styles if necessary.

LITERATURE REVIEW

A. Clinical Laboratory Management Systems

Nolen (2022) expands the concept of Laboratory Management Systems (LMS) that improves the laboratories' patient care and value chain. This combination is crucial for assuring control of processes that allow laboratories to identify and improve on the critical steps of the pre-analytical, testing, and post-analytical stages. Consider that the processes outside of the laboratory account for six times the error frequency of those processed internally. These statistics and insights from the current workflow of clinical laboratories lead to the research question of how small-sized clinical laboratories can successfully begin their automation using data analytics to control their phases and activities.

What areas of the workflow should become automated first? And how can small sized clinical laboratories introduce these automation changes through a LMS?

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This research assesses the significance of managing the massive data that clinical laboratories gather every day and how it can optimize their operations using an opensource statistical programming tool.

B.What Is R, And What Are Its Benefits?

As a statistical programming language, R allows laboratorians and others to transform and analyze data and communicate results. It includes a wide variety of capabilities that provide greater functionality for working with data than Microsoft Excel and other commercial data analysis programs. R uses text-based commands to process data, and as such it functions as a full-fledged programming language for the advanced user.

Unlike Excel and many other graphical user interface (GUI)-based programs, R's reliance on text-based structure makes it straightforward to review at any time the commands used in a data processing pipeline to ensure that the correct steps were taken. Furthermore, the ability to view the underlying commands facilitates transparency and reproducibility of analyses.

The same text commands are used regardless of the size of the dataset; thus, it is just as easy for the user to perform an analysis on 1 million test results as it is to perform that analysis on 10 results. This feature makes it simple to automate and scale any process with R. In addition, the graphing capabilities of R far surpass that of Excel and many other GUI-based programs, in both functionality and potential for customization and automation

C. Performance Excellence Framework

When designing the laboratory workflow and environment, the working space needs to provide accommodation for automation and new advanced instruments. Small-sized laboratories have opted for alternative solutions since they cannot afford the investment of automation for clinical laboratories. The Center for Disease Control and Prevention (CDC) collaborated with the Association of Public Health Laboratories, and launched the "Laboratory Efficiencies Initiative" (LEI) in 2013 that focuses on maintaining the clinical laboratories' cost and operating efficiency through the adoption of management procedures and practices.

METHODOLOGY

A data-driven application prototype will be introduced to small sized clinical laboratories based in the nation using the R Programming language. The R

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Programming provides an IDE platform, RStudio that allows the creation of web-based applications using Shiny App, and integrating a combination of packages from the Comprehensive R Archive Network (CRAN) repository.

R is widely used and supported within statistical communities and data-driven industries. Given the rapid pace of development in analytical techniques, such as machine learning or artificial intelligence, it is important that software packages continually evolve. The two dominant choices for data science as of this writing are R and Python (also freely available), and in both cases it is now possible to adapt code developed on one platform to run on the other. Consequently, for almost any statistical method, new or old, there is likely at least one freely available add-on package to implement it within the R environment. These packages are available on popular software-hosting sites, including the Comprehensive R Archive Network.

R Shiny Dashboard

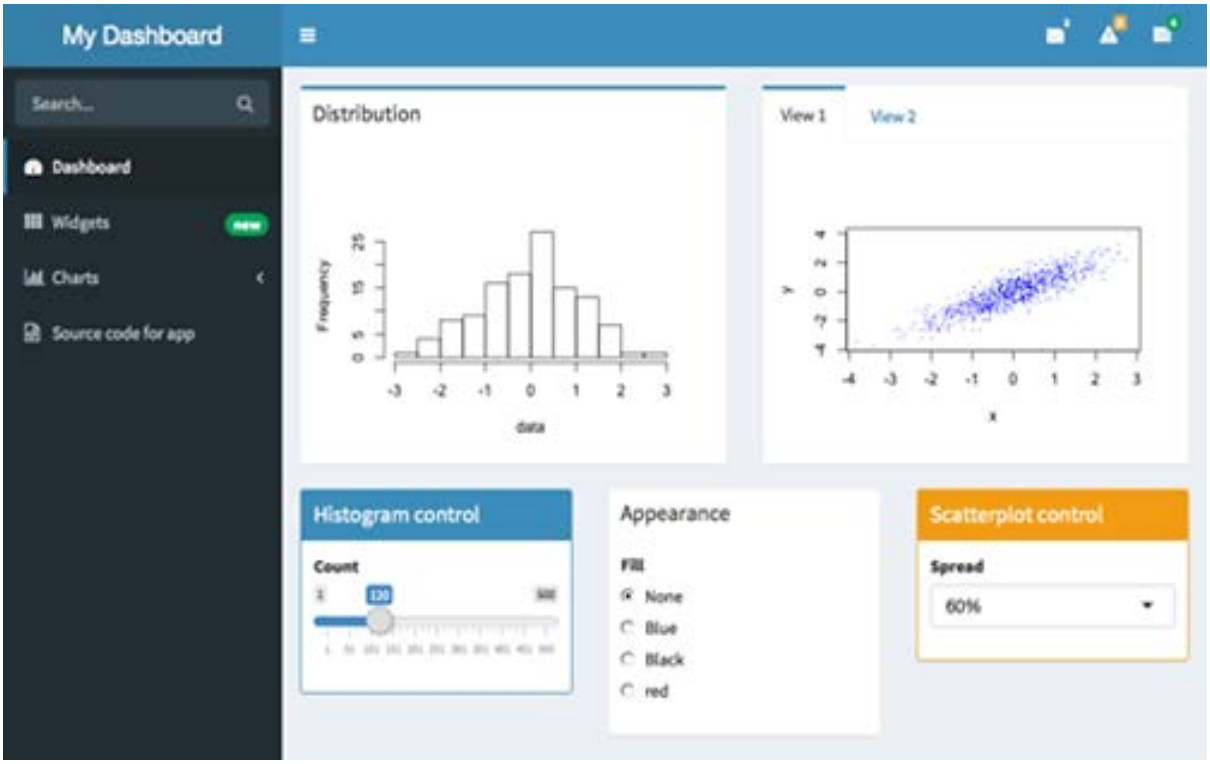


Fig.1. demonstrates the current prototype built with R Programming and ready for testing in small-sized clinical laboratories.

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The User Interface (U.I.) presents a menu sidebar with four tabs indicating KPIs, Pre-Analytic Phase, Testing Phase, Post-Analytic Phase, Clinical Laboratory Costs, and Inventory. Some of these plots allow the user's input and selection of features to update graphs and analyses using real time data.

CONCLUSION

The automation mindset of today emphasizes supporting clinical laboratories to meet the demands while overcoming the Challenges of the field, economic factors, and healthcare crises.Future directions of this study suggest integrating this platforminto the information systems architecture of small-sized clinical laboratories throughout the nation. Further training canbe provided to laboratorians and staff members to learn thenecessary skills of R Programming as an open-sourceapplication. This significant step will encourage thetransformation of small-sized clinical laboratories into a Next-Generation.

REFERENCES

1. J. Yundt-Pacheco, M. Gersh. Reducing errors in the clinical laboratory, Medical Laboratory Observer, pp. 8 – 12, March 25th, 2020 [Online] Available:MLO,https://www.mlo-online.com/continuingeducation/article/21130581/reducing-errors-in-the-clinical-laboratory

2. J. D. L. Nolen, ”The power of laboratory automation, Medical Laboratory Observer, pp. 12 – 13, January13th, 2014, [Online] Available: MLO https://www.mloonline.com/home/article/13006042/the-power-of-laboratory-automation [Accessed Jun 26, 2020]

3. https://www.researchgate.net/

4. https://ieeexplore.ieee.org/document/9457911

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