Application of LIMS laboratory information management system in testing laboratory

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Abstract. LIMS laboratory information management system, with testing business process management, quality control management, comprehensive resource management, query and statistics and other functions. It adopts B/S development mode, designs and develops based on 5-level architecture, and adopts MySQL database to ensure high security and reliability of the system. The data collection of more than 150 inorganic and organic indicators has been preliminarily realized, the laboratory data collection work has been completed, and the method of comparison with the manual transcription report has been adopted to verify the reliability of the laboratory test data and improve the efficiency and management level of the laboratory.

Keywords: LIMS laboratory management system; data acquisition automation; Water quality testing.

Laboratory information management systems have been developed in laboratories in developed countries as early as 20 years ago, and are widely used in food, pharmaceutical, electric power, chemical, education, and scientific research industries (Nie Zhenzhen et al., 2019). By the end of 2018, the coverage of LIMS in China's detection industry can reach 15%~20% (Zhang Cong, 2019). Similarly, in recent years, more and more environmental monitoring departments in various provinces and cities in China have begun to apply.

In the early 90s of the 20th century, the blank form format of all the original records and reports in the laboratory was unified and fixed, and it was printed in batches, and the reports were manually copied and preserved on paper. In 2000, with the popularity of computers, Office office software began to be applied, the application of Excel made calculations much more convenient and faster than typing calculators by hand, Word made the report can be machine-typed, goodbye to hand-copied reports. At the same time, the laboratory has more than 50 sets of advanced instruments and equipment such as ion chromatography, ICP-OES, ICP-MS, gas chromatography-mass spectrometer, etc., which can undertake the detection of more than 200 indicators such as inorganic and organic. It is necessary to provide a large number of real and reliable testing data every year, in order to further solve the problems and shortcomings in the current soil testing work, change the unfavorable situation of relatively lagging test data submission, and introduce a laboratory information management system to promote the improvement of soil testing capabilities and levels. Combined with the working characteristics of soil testing, the LIMS system has developed a characteristic quality control system suitable for soil testing, which effectively improves the quality of testing work and laboratory management.

1. Overview of LIMS

With more than 30 instruments and equipment connected to the network, only a small number of instruments and equipment such as turbidity meters, electronic balances, ultraviolet spectrophotometers, etc. can not be put online temporarily, LIMS can realize laboratory-centered, testing data and related information collection, analysis, reporting and management, it will network communication technology, computer technology, analysis and testing technology, instrumentation technology and scientific laboratory management ideas organic combination, giving us an information management platform. Combined with the characteristics of environmental monitoring, six subsystems are customized for the laboratory, including: testing business process management subsystem, resource management subsystem, testing data quality management subsystem, analysis original record management subsystem, data management subsystem and instrument data automatic collection subsystem

2. Introduction to LIMS subsystem functionality

According to the specific business situation, each subsystem has been developed in a targeted manner.

(1) Detection of business process management

Including project registration, sample receipt, data analysis, data mutual review, report pre-review, report preparation, report issuance and report archiving of the whole process management. Combined with the characteristics of the soil testing room, the report pre-examination function has been developed, which can return samples with unqualified quality control for retesting.

(2) Resource management

Comply with the requirements of ISO/IEC 17025 standard specifications, realize all-round management closely related to testing quality, and improve the comprehensive management level. Including personnel management, instrument and equipment management, sample management, standard reagent management, file management, testing method management, testing project management, evaluation standard management, monitoring object management and subcontracting management. And can effectively monitor the factors that affect the quality, and associate the personnel qualification, instrument and equipment verification and calibration status, the effectiveness of method standards, the effectiveness of standard reagents, cultivated land compliance evaluation, etc. with the testing work, and there is an alarm function when it does not conform. Quality management personnel can query relevant information and conduct quality tracking (Lin Yan et al., 2019; Zhu Guangfu et al., 2019; Zhang Jingbo et al., 2013).

(3) Quality management of test data

Control the internal management of laboratory test data from the aspects of on-site parallel samples, laboratory parallel samples, whole program blanks, certified standard samples and self-made standard samples. The relative deviation of parallel samples can be calculated, and the test results can also be automatically evaluated according to the standard values of quality control samples (Song Shengpan, 2017; Zhou Huanyu, 2019).

(4) Analysis of original records management

The system integrates the original record template, establishes the corresponding original record template in the system, extracts the entrusted information, sample information, analysis parameters, and analysis methods into the original record, and automatically collects the result data in the original record, as well as automatic formula calculation, automatic revision (can be modified in segments according to different concentrations), automatic determination of detection limit (organic projects can set different detection limits according to different projects for different requirements of detection limit), automatic unit conversion, automatic calculation of quality control indicators, Automatic determination of sample results and quality control results, automatic signature and automatic statistics, and finally automatic synthesis of electronic original records, to realize the original records of all indicators electronically.

(5) Data management

Realize the comprehensive management of comprehensive data, automatically generate and export test data, test reports and various query statistical reports, such as DOCX, XLSX, PDF and other formats of instrument output files or charts, and support the statistics and query of various data and information (Shuai Chuang et al., 2019). Combined with the latitude and longitude information of each well, in the future, the trend map of the historical data of the sampling point can be automatically generated on a geographical map, and the detection results can be compared and analyzed with the historical data, which is especially important for the analysis and management of these data.

(6) Automatic collection of instrument data

The data analyzed by the instrument can be automatically uploaded to the LIMS system, and the LIMS system can automatically complete the processing of the original data, such as calculation, revision, unit conversion, curve generation and over-standard determination, and finally generate the original record. Through the automatic collection of instrument signals, not only reduces the workload of analysts to transcribe data, but also avoids errors and deviations caused by manual transcription, and the system will automatically save the uploaded data and spectral files to ensure the traceability of data (Meng, 2020)

3. Application characteristics of LIMS

(1) Complete quality assurance system

Follow the guidelines ISO/IEC 17025, which is convenient for laboratory managers to comprehensively manage and control many factors that affect laboratory quality, and comprehensively and thoroughly manage various laboratory resources such as laboratory environment, instruments and equipment, standard solutions, personnel and method standards.

(2) Automatic acquisition of instrument signals

Data is electronic, realizing paperless office, not only saving paper, but also facilitating data query. Previously a large number of originals

At the beginning, the records were filled with several cabinets, which were not convenient to consult, and now it saves space and time.

(3) Quality information technology

After the establishment of the information management system, from the perspective of work quality control, the following problems can be solved:

First, quality problems can be exposed intuitively. Such as anion and cation summary table, report data summary table, quality control report and analysis task query table, etc., in the past, analysts had to report the quality control test data of each project to the quality management personnel, and the management personnel should first collect the data and then carry out quality control work. The collection and collation of data takes up a lot of time, and problems are often not detected in time. Now we can free ourselves from the tedious work of collecting and organizing quality information and focus on quality control. Solves a problem that has been plaguing quality control personnel.

The second is to help quality management personnel find problems, confirm problems, solve problems and trace the problems generated by quality. The system can record the data of each link in the business process in detail, and the question data can be traced back in time. In this way, the authenticity and fairness of the data are improved, the quality control and supervision of the whole process of daily work are realized, and the level of quality management is improved. LMS quality management can develop a special and characteristic quality control system suitable for soil testing, and add quality control methods such as correlation of different indicators, so that quality problems can be found in time and retested in time.

(4) Data confidentiality

LMS systems need to be equipped with a dedicated LAN system to ensure information security. The system divides the management authority according to different job responsibilities, that is, a user has only one set of operation permissions. Users can associate multiple roles according to their

own needs, and different roles have different operation permissions, so as to strictly control data access for different operators. Each operator needs a password to log in (Yang Xiaoxue, 2019).

(5) The system adopts architecture and database

The system adopts B/S development mode. The client can be used normally without installing software, reducing the workload of system maintenance. The system architecture mainly includes five levels of functions: application infrastructure layer, information resource layer, support layer, application layer and information display layer. The database uses the MySQL database, which is an open source relational database management system, so anyone can modify it according to their individual needs. It is adopted for its speed, reliability and adaptability

LIMS has limited hardware and software requirements for computers, so the investment is low. The system adopts the design of B/S structure, with zero maintenance of the client, which supports the continuous improvement of the quality system and is conducive to investment protection. This kind of development and maintenance must be long-term, because the laboratory work continues to develop and change, constantly expand new testing items, testing methods, add instruments and equipment, instrument and equipment software upgrades, etc. all require the LIMS system to make continuous adjustments and improvements to ensure the smooth progress of laboratory work.

(6) System management and maintenance

System management and maintenance is of great significance to ensure the normal operation of the LIMS system. System administration and maintenance includes the setting of operation permissions, the management and maintenance of system databases and system access logs, etc. Among them, the management and maintenance of the database is particularly important, because the system runs every day to generate a large amount of data, and the effective storage and backup of these data are very important. In order to ensure data security, the database is backed up regularly to achieve data backup and recovery. In addition, the laboratory is equipped with a dedicated business administrator to maintain monitoring templates and basic test libraries.

4. Status and development trend of LIMS usage

The LIMS laboratory management system mainly completes the use of core functions such as data collection and report preparation directly related to the testing work, and initially realizes the requirements of quality management, which initially shows its superiority. The analysis and utilization service of soil test results is the focus and trend of the future development of the system, and the system automatically completes the statistical work of a large amount of data (Lin Shu et al., 2018); Through the detection data accumulated in the system, the statistics and analysis of various indicators of the detection project can be realized, such as the analysis of major pollutants, the detection rate of the detection index, the analysis of the excess rate, etc.; Provide rich chart functions to enhance the intuitiveness and expressiveness of data, such as curves, histograms, and pie charts. In this way, the historical data can be analyzed and compared, and the dynamic changes of indicators can be further grasped, so as to achieve the purpose of making full use of the basic data and materials, and effectively combine the geographic information and GIS applications in the environmental monitoring business

In the field work, you can consider pH, conductivity and other on-site test data instant upload, in short, the system construction work is difficult to achieve overnight, laboratory personnel are gradually understanding, gradually mastering, and promoting the gradual improvement of the system, in order to help the business development of the laboratory.

5. Conclusion

LIMS laboratory information management system has realized automatic collection of laboratory data, automatically completed various calculations in test records, automatically generated original records and test reports, and realized the automation of workflow. It greatly improves the timeliness

and effectiveness of data. It will continue to focus on on-site testing and laboratory analysis and testing, and organically combine various factors affecting the detection data such as man, machine, material, method, and environment to carry out comprehensive control and management. Make the operation of the entire quality management system more scientific and rigorous. With the rapid development of the economy, the business of the laboratory is also developing rapidly. Through the application of modern computer network and other technologies, the future testing laboratory is highly professional, intelligent, systematic and automated. Therefore, the existing LIMS with information management as the theme will continue to be adapted to the requirements of the development of testing laboratories.

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