Abstract

Dozens of samples are analyzed daily in the Sector for Laboratories of the Mining and Metallurgy Institute, based on which the reports of analyses are formed. Former approach to creating these reports included a manual report design, sample marking and template preparation with Microsoft office tools, which can be time consuming and error prone. Automating these tasks through a software solution became a necessity in order to optimize the reporting process. System includes the automatic report creation, analysis result entry, standard and method record and its assignment to a specific employee. Regular updates would improve the overall picture of a complete laboratory as well as for every individual employee. System uses the “Oracle 11g XE” database, “iReport” (“Jaspersoft Studio) for report design and “Oracle APEX” application design tool, while the application is deployed on the “Glassfish” application server. Necessary hardware consists of quad core processor, 4 GB memory and 500 GB HDD.

Keywords: laboratory analysis, Oracle 11g XE, Oracle APEX, iReport, Jaspersoft Studio, Glassfish

INTRODUCTION

In order to round and complete its activities, the Mining and Metallurgy Institute Bor has owned for many years the modern and accredited laboratories for:

1. Laboratory for Chemical Testing, CTC,
2. Laboratory for Mineral Processing, PMR,
3. Laboratory for Geomechanics and Soil Testing and
4. Laboratory for Electrical Measurements [1].

Every material needs to be analyzed since the useful or harmful trace elements can appear. Analyses are performed using various methods that are defined by specific accredited or non-accredited standards.

Generally speaking, the system that provides such service consists of several tiers:

1. Presentation (client) tier,
2. Logic (application) tier and
3. Database (persistence) tier.

![Multitier architecture](image)

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Every tier (Figure 1) has its own purpose, but some tasks can be performed on different tiers simultaneously. Presentation tier involves the user interaction with an application using tools like the web browser. Interaction includes the communication establishment with an application and sending it user commands [2].

Logic tier represents an application that is deployed to an application server, in this case the Glassfish. Application processes received data and decides how it will interpret them (Business logic) [3]. Communication can be established with database if it’s necessary. Let’s say that the user enters his password. Application establishes communication with a database where passwords are stored and depending on the interpretation, the user gets an appropriate feedback. Application can perform some of its own checks like number of failed login attempts, or an IP address from which the user is connecting.

Database tier represents the data storage in separate tables which are connected in a meaningful way. Data is extracted from tables and sent back to application. Database, just like an application, can also implement some sort of data checks and constraints. Storage is provided by the Oracle 11g XE database.

PROBLEM OVERVIEW

Current report processing includes the unique sample identification, their analysis, result entry, report printing, archiving in hard copy and sending reports to the clients. This task gets complicated as the amount of job increases. In cases where calculations are needed, Microsoft Excel Macros would be required and after that, a report would be created using Microsoft Word. Standard and method maintenance also requires a special attention since non-accredited standards are maintained separately by every department. It is not uncommon for one standard to be mistakenly defined differently by two or more departments.

SOLUTION

Application can be divided into four logical sections:
1. Reception,
2. Result entry,
3. Administration and
4. Printing.

At the moment, not all features are available since application is still in its test phase. Every employee has its own role and privileges with specific responsibilities. Reception group create templates while technicians enter analysis results based on these templates. Template is first prepared through the sample identification, then forwarded to the technicians for result entry and finally, the chief engineer checks and confirms those results. Idea is that every employee sees standards and reports he is in charge of.
I Data Entry

In order to insert results, the technician needs to wait for necessary template preparation by the receptionist. All requests are forwarded to the reception group for its pre-process which includes the report header definition like the client name, report ID and deadline among other things that should appear on the front page, as shown in Figure 3.

Figure 3 Front page

Reports are usually formed in same way, but there are some exceptions like the Geological Reports. Because every client usually requests the same kind of reports, term “group” (template) is introduced to simplify the reception task. Groups are formed only once and choosing one of them defines a sample with all elements from that group. Samples are labeled and finally forwarded to the technicians for result entry. Elements can be added afterwards if client request differs from predefined group.

Sometimes even technicians do not know how analysis will be performed. In
that case, the multiple standards are used and one chosen by the chief engineer can be joined to a specific group. Usually, the results are entered manually in appropriate fields, but in some cases data can be imported from an external source like CSV file (Figure 4). Technician uploads that kind of file for further processing and after that, database enters correct data in the appropriate fields. Elements can be added to the current report by technician, but that element will not appear in any of the predefined groups.

Figure 4 CSV file

Chief engineer checks and confirms entered results and signals recipient that report is ready for printing. He also must ensure regular standard updates because they define the analysis method. If any standard needs some sort of modification, like label, element or compound, then chief engineer must carry out that task also. Regular standard updates reduce confusion and conflicts among other employees since groups are defined using those standards.

2 Results

As stated, the chief engineer signals that reports are ready for printing, while recipient prints and, for the sake of simplicity, marks them as “printed”. Reports are printed in PDF or RTF format and, if needed, type of reports can be changed since horizontally ordered elements (Figure 5) are sometimes more readable than vertical ones (Figure 6). Unfortunately that is not always the case, and special report design was needed for some reports like geological, as shown in Figure 7. Reports are archived in the paper format, but the recipient can print any report at any time since all data is kept in database. Database backup means a complete database copy, but that is part of the database administrator’s job. Backups should be saved on different medium due to the unpredictable server failures.

Figure 5 Horizontal result report
**Figure 6** Vertical result report

**Figure 7** Geological report
CONCLUSION

Data centralization makes it suitable for further analysis, but to achieve this, system needs to be maintained constantly. Report backup, part of the system maintenance, is simpler than copying every report in the paper format, which is one of the database advantages. Current system state provides the basic functionality but unfortunately lacks some authorization mechanisms due to the frequent laboratory organizational structure change. It should be noted that beside the Institute, this system can be used in other laboratories as well.

REFERENCES