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MINING AND METALLURGY INSTITUTE BOR LABORATORY INFORMATION SYSTEM

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 of 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.

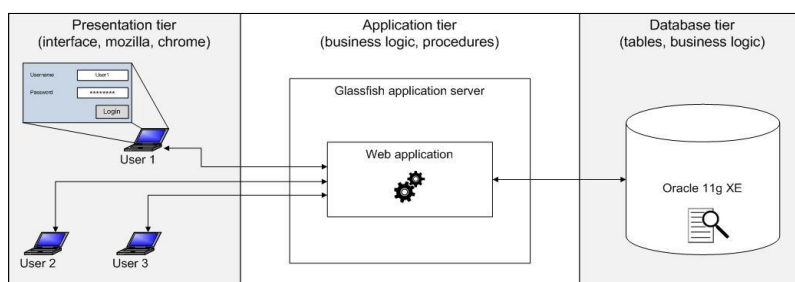


Figure 1 Multitier architecture

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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.

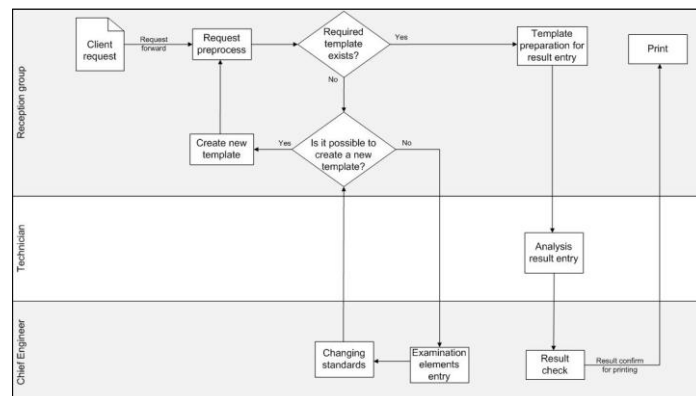


Figure 2 Simplified report creation process

1 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.

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РТБ Бор Група ТИР Електролиза Р.Ј. за производњу бакар-сулфата		Датум: 07.02.2016 Date:	
ИЗВЕШТАЈ О ИСПИТИВАЊУ бр.195130-544/2016			
1. Датум пријема узорка: 04.02.2016 2. Врста / шифра / порекло узорка: Бакар-сулфат -/ Р.Ј. за производњу бакар-сулфата/ 3. Посебни услови / допуна / одступања везана за узорковање: 4. Допуне, изузимања, или одступања везана за испитивања: ISS је тренутно у фази промена стандарда за плави камен.			
Метода:	EG	електрогравиметрија	СРПС X.ПВ.110:1989
	G	гравиметрија	СРПС X.ПВ.112:1989
	G	гравиметрија	СРПС X.ПВ.113:1989
	V	волуметрија	СРПС X.ПВ.113:1989
	G	гравиметрија	СРПС X.ПВ.114:1989
Извештај припремио:		Управник Лабораторије за хемијска испитивања	
Број јединица:			
Достављено:	1 x Архиви Лабораторије за хемијска испитивања 1 x Координатору Лабораторије за хемијска испитивања 1 x Партнер		
- Дати резултати се односе само на испитане узорке - Извештај се не може униожавати без одобрења управника Лаб. за хем. испитивања - Жалбе и рекламације на наш рад можете упутити директору Института за рударство и металургију - Број јединица одређивања дефинисан је по важећем ценовнику Лаб. за хем. испити.			
QF-957.104 Насловна страна - Извештај о испитивању Издање обр: 2 Матични документ QF-959.34, Прилог: 4			Стр 1 од 2

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 group.

	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT
1	ZN5	FLG_PB2	PB2	FLG_FEB	FEB	FLG_N12	N12	FLG_AL7	AL7	FLG_P1	P1	FLG_S13	S13	FLG_MN1	MN1	FLG_S	S	FLG_CD1	CD1	FLG_B14	B14	FLG_CR1	CR1	FLG_S81	S81
2	0.00082		0.0101		0.00577		0.02864		0.00013		0.00007		0.00018		0.0001		0.00288		0.00002		0.00174		0.00002		0.00288
3																									

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.

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.

2 Results

As stated, the chief engineer signals that reports are ready for printing, while recipient prints and, for the sake of simplicity,

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Извештај о испитивању бр.195130-544/2016					
	Cu (%)	Fe (%)	материје нерастворне у воде (%)	% слободне FeSO ₄ (%)	Поверљивост анализе (%)
3801-4000 лл	25.24	0.027	0.021	0.03	0.19
01-200 лл	25.14	0.026	0.007	0.06	0.58
Аналитичка метода	EG	G	G	V	G
Стандард	СПС Х.ПБ.130.1989	СПС Х.ПБ.112.1989	СПС Х.ПБ.115.1989	СПС Х.ПБ.113.1989	СПС Х.ПБ.114.1989
Крај извештаја о испитивању.					
Издање 2	QF-957.104 Остале стране - Извештај о испитивању				Издање обр: 2
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Figure 5 Horizontal result report


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Извештај о испитивању бр.195130-544/2016					
Елементи	3801-4000 л/в	01-200 л/в	Метод	Стандард	
Са (%)	25.24	25.14	EG	СРПС X.ЛБ.110.1989	
Fe (%)	0.027	0.026	G	СРПС X.ЛБ.112.1989	
материје нерастворне у води (%)	0.021	0.007	G	СРПС X.ЛБ.115.1989	
% слободне H ₂ SO ₄ (%)	0.03	0.06	V	СРПС X.ЛБ.113.1989	
Плорашиска вода (%)	0.19	0.58	G	СРПС X.ЛБ.114.1989	
Крај извештаја о испитивању.					
Издање 2		QF-957.104 Остале стране - Извештај о испитивању		Издање обр: 2	
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Figure 6 Vertical result report


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Извештај о испитивању бр.195100-31/2015								
РВ19/14					Анализа	Композит		
Р. бр.	Од	До	Интервал	Број пробе	Cu%	S%	Ag%	Au%
1	158	161.1	3.1		0.65			
2	161.1	162.7	1.6		0.42			
3	162.7	164	1.3		1.03			
4	164	166	2		0.49			
5	166	168	2		0.67			
K	158	168	10			2.23	1.80	0.70
6	168	170	2		0.79			
7	170	171	1		1.01			
8	171	173	2		0.86			
9	173	175	2		0.83			
10	175	177	2		0.55			
K	168	177	9			5.09	3.10	0.40
Аналитичка метода					AAS	S	FA	FA
Стандард					БМК Е.х.1.1994	*БМК Е.д.1:	СРПС S.FB.473.1981	СРПС S.FB.473.1981
Крај извештаја о испитивању.						Стр 2 од 2		
Издање 2		QF-957.104 Остале стране - Извештај о испитивању		Издање обр: 2				
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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.

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