

CHEMICAL INVENTORY AND MANAGEMENT IN PTFI QUALITY CONTROL LABORATORY

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ABSTRACT

Tracking in chemical inventory and management are important for safety-health-environmental (SHE) management system as regulatory and challenging laboratory organizations. SHE compliance, minimization of hazardous waste, responses and preparedness for emergency, and all benefit by knowing what they are exist and located, which has responsibility. PTFI Quality Control Laboratory developed an application by web-based system for chemical inventory information and information management, including for report of compliance. Chemical inventory and information management are using to meet of regulation requirements. Its system can obtain hazard identification (HAZID), chemical storage compatibility, flammable liquid, and hazardous materials emergency procedures to prevent they become problem issues. This paper explaining for an inventory programs proposed methodology used to entity relationship diagram (ERD) from relational database schema, and databases demonstrated to meet hazardous materials issues, and it will be useful for chemical coordinator to maintain and manage chemical inventory and management.

INTRODUCTION

Inventory management is a very complex problem area and complexity that has necessitated the development of intelligent system to assist decision-making (Boylan, *et al.*, 2008). PTFI is company that runs in copper and gold mining and has been in operation at Mimika Regency, Papua Province. There are many divisions at PTFI to support every mining activity. Among them is Quality Control Laboratory that plays an important role in the separation of valuable minerals and the concentrate dewatering process which uses complex processes, high technology and a huge number of human resources (Susanto, *et al.*, 2013). The use of hazardous materials is strictly monitored and managed, because can create danger or accident. It is also give a huge impact for the environment if their utilization and management not conducted well and suitable.

Decree of the Minister of Mines and Energy No. 555.K/26/M.PE/1995 (Decree of the Minister of Mines and Energy of the Republic of Indonesia,

1995) and Government of Indonesia Regulation No. 74 year 2001 (Regulation of the Minister of Industry of the Republic of Indonesia, 2013) issue authoritatives instruments to applying and also establishing chemical management. A minimum requirements have to defined for chemical, including the training and qualifications for personnel involved in chemical work, documentation for chemical, work authorization and approval, documentation and safe-work process. These requirements, which make up a program of chemical management, ensure that worker SHE are protected, pollution prevention, and assist to emergency preparedness and response, and minimize hazardous waste by chemical activities control.

Chemical inventory management is becoming essential tool, methods for collecting data are available. The real challenge is to linkage the container of chemical information to hazard reference data to comply with regulatory requirements. Data management including category of hazardous aggregate-chemicals. A web-based requires

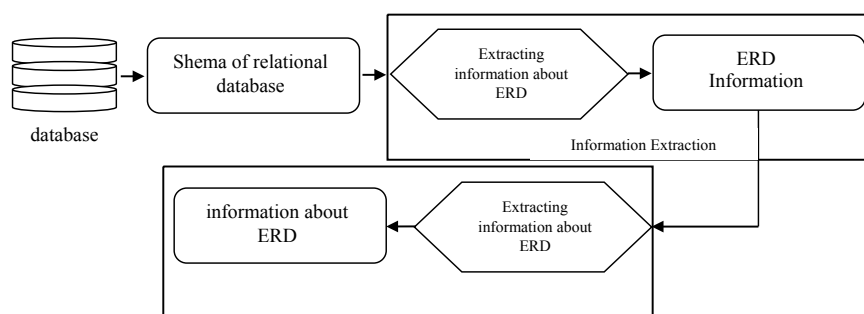


Fig. 1 Diagram for chemical inventory ERD and database schema in quality control laboratory.

only a web browser connected to the ethernet to access reference database and a comprehensive management system for identification, reporting and tracking for used of chemicals in quality control laboratory.

METHODOLOGY

Two steps of the methodology: information extraction and ERD (Fig. 1) and observational study. First step for information extraction focuses to the attribute, keys, determination of constraint, and done with information extraction about ERD from schema of relational database, that obtained from a database (Al-Masree, 2016).

The observational study is on chemical management by identifying such factors as: hazard identification, chemical storage, flammable liquid and dangerous materials emergency preparedness and responses, and then compared with the standard from United States Mine Safety and Health Administration (MSHA) Regulations: 30 CFR Subpart C, flammable and combustible liquids and gases; standard AS/NZ 3833: the storage and handling of mixed classes of dangerous goods in packages and intermediate bulk containers, and globally harmonized system (GHS) of classification and labeling of chemical.

Literature review

Entity relationship diagram (ERD): Entity relationship diagram (ERD) is familiar diagram, which aims to present the database structure in conceptualized form. To build good ERD and excellent schema depends on type of word (verb, noun, adjective, and gerund) (Chen, 1983). The can generated from database cause it understandable and simple diagram. Extract ERD schema set from an operational relational database (Xu, *et al.*, 2013). Designers must use tools to reach best implementation of these methodologies by ERDraw to represent ERD and translate to schema of relational database [6].

Chemical management: At company with chemical work activities, managing inventories of chemical

at laboratory identified as one of SHE management compliance. According EPA, institution have to create and implement a chemical inventory and management system because the lack of it operational as a root cause of the compliance problems encountered [8].

A chemical inventory defined as record (written and/or electronic) of tracked chemicals at work area by containment includes the name of chemical abstract service (CAS) number, manufacturer and information such as the size of container, the material in the container, the owner, and the location by building and room number. In particular, specific activities will list the chemical used in a chemicals operation. Certain chemicals (known human carcinogens, chemicals of high-acute or high-chronic toxicity, or known human productive toxins) shall be used in designated areas in which is access is restricted to authorized personnel [9].

Hazards and the situations or circumstances in which they could cause harm must be identified and evaluated to determine whether controls are needed to reduce the risk to an acceptable level. Chemical compound databases that contain hazard, health, and physical properties with National Fire Protection Association (NFPA) ratings are commercially available [8]. Controls must be defined (or developed) and implemented, as needed, to reduce the risks associated with the work to an acceptable level.

The extremely simply user interface; resulted in no waste of management time for training [10]. Most chemical inventory systems track chemicals by room location, breaks down location to cabinet and shelf. Storage compatibility fields are used in conjunction with storage locations [8].

RESULT AND DISCUSSION

Chemical inventory entity relational diagram

Extracting information process uses the schema of relational database (Fig. 2) as main input, and depend to contain data on the table, or depend to

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CInv_Department : (DepartmentID, DepartmentName, DepartmentRootID)
CInv_Employee : (UID, Name, Email, DepartmentID)
CInv_Storage : (StorageID, StorageName, StorageDesc, StorageCode, DepartmentID)
CInv_UserAccess : (UID, Password, IsAdmin)
CInv_Container : (ContainerID, ContainerName, ContainerDesc, StorageID)
CInv_ItemStock : (ItemStockID, ItemID, ContainerID, TotalQuantity, StorageUnit, EntryDate,
ExpiryDate, BatchNo, CreatorUID, CreationDate, SDSFile)
CInv_ItemTransaction : (ItemTransactionID, ItemStockID, Quantity, Remarks, TransactionUID,
TransactionDate)
CInv_Item : (ItemID, ItemName, CASNumber, ItemDesc, ItemCapacity, StorageUnit,
ManufacturerID)
CInv_MeasUnit : (MeasUnit, MeasUnitDesc)
CInv_SignalClass : (SignalClassID, SignalClassName)
CInv_ItemDGClass : (ItemID, DGClassID)
CInv_DGClass : (DGClassID, DGClassName)
CInv_Manufacturer : (ManufacturerID, ManufacturerName, ManufacturerDesc)
CInv_ItemHazard : (ItemID, HazardCodeID)
CInv_HazardCode : (HazardCodeID, HazardCodeDesc)
CInv_ItemPrecautionary : (ItemID, PrecautionaryCodeID)
CInv_PrecautionaryCode : (PrecautionaryCodeID, PrecautionaryCodeDesc)

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Fig. 2 Database relational in quality control laboratory.

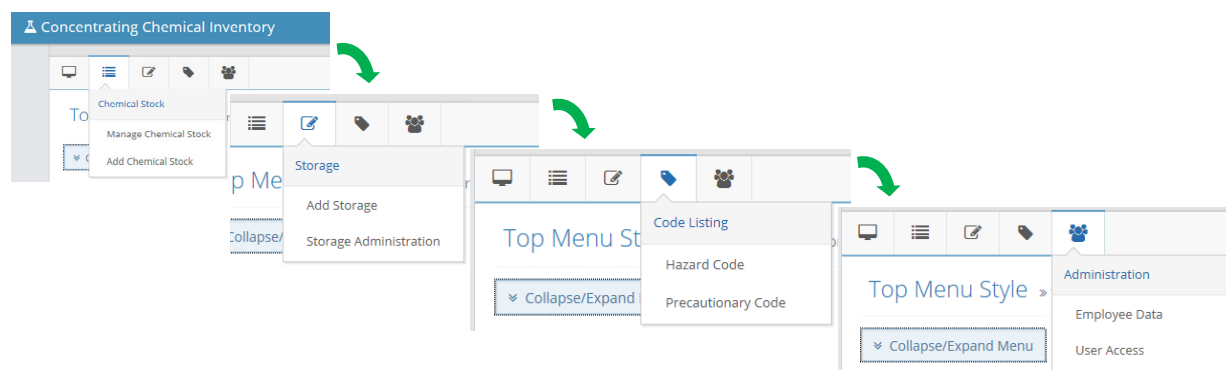


Fig. 3 Quality control laboratory web-based application.

database script code. The first view to the relational database schema some information becomes clear and on closer examination some important defined. Information contains of database about attributes, entities and relationship between these entities. Fig. 3 and 4 presented ERD from database relational and validation of the extraction results used by more advances rules and based on keywords, and depend on the table that contains data or script code of the database.

Chemical inventory and information management obtain to regulatory implementation concerning hazardous materials. Chemical identifying illustrates that while chemical work requires a HAZID database that describe the physical and health issues associated with each chemical.

The system track storage location to the cabinet with enough specificity to determine whether chemicals are proper stored as storage requirements, including storage compatibility concerns, regulated limits, and proper containers, and containers with more specificity to shelf make chemicals more easy to find.

Regarding the Chemical HAZID database, the values entered into these fields must be accurate. As with all

types of data used in computer-generated reports, the quality of the information being generated depends on the integrity of the information it contains. Even a moderate degree of inaccuracy can erode confidence in system and discourage use.

Fig. 3 presented a system of users, owners of chemical and group. Chemicals are linked within a chemical coordinator, and it allows users in different categories to access and recall the information to perform their keys responsibilities. For example, quality control department head have access and authorized to all chemical inventory, reporting and users administration, and meanwhile a chemical coordinator only need the ability to add new inventory and/or delete obsolete inventory. Different categories provided varying levels to access and recall the data and information, based upon their used and need of the information.

Hazard identification

Hazard Identification Program signs at laboratory locations where hazardous materials are used or stored, and should be posted. Many countries have certain regulation systems for chemical materials labeling types, requirements and classifications

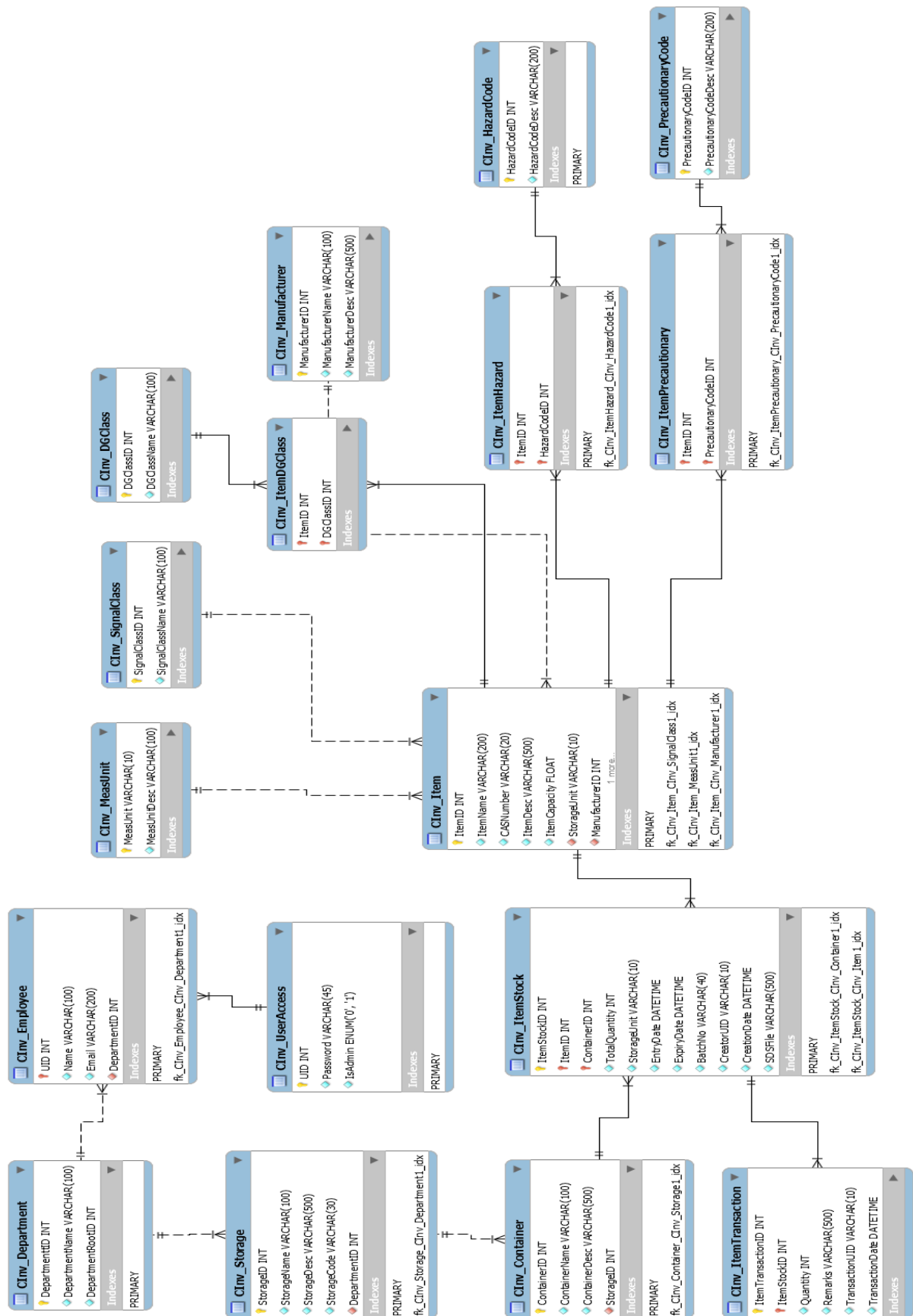


Fig. 4 Chemical inventory ERD in quality control laboratory.

[10]. However, the differences are quite significant for classifications, symbols and label, safety data sheets (SDS) of the same products, when they are on markets in many countries. Even in the same country, when different controlling authorities close parts of the chemical materials' life cycles. This causes a protection consistency for those who potential affected by chemicals, as well as creates a wide regulation burdens for companies that produce chemical materials [11].

For hazard communication (HAZCOM), Quality Control Laboratory used GHS (Fig. 5), while this system communicating hazard information in prescribed and uniform way chemical management should cover a system where hazardous chemical materials are identified and communicate to all potentially affected people. These groups include the workers, customers, emergency respondents, and community. This is also important to know the available or used chemical materials, the danger for human's health and environment. Even though the available laws and regulations are similar in every country [13], they are quite different in terms of their requirements and labelling for the same products.










GHS SYMBOLS AND MEANINGS	
	Acute toxicity via oral, dermal or inhalation
	Oxidising substances
	Aspiratory or respiratory hazard, carcinogenicity, mutagenicity
	Explosives, self-reactive substances, organic peroxides
	Hazardous to the environment
	Compressed, liquefied or dissolved gases
	Flammable, pyrophoric, self-heating substances; water reactive
	Corrosive, skin damage, eye damage
	May cause immediate health effect – skin, eye, respiratory

Fig. 5 GHS classification and symbol.

GHS implementation in quality control laboratory are direct connected to the final objectives and their levels of danger. Other labelling elements are harmonized with the available terms and/or principles included in GHS are pictogram (convey information for physical, health, and environmental hazard); signal words ('Danger' or 'Warning' used to emphasize hazards); and hazard statement.

Based on Fig. 3, describe the flow of chemical inventory and flow of how to save the chemical storage with safe from transaction until saving into storage. With the chemical inventory web-based programs, the laboratory will get easy to do chemical materials inventories, like an input and output information materials, expired date, materials characteristic, safety equipment to use, etc.

Storage compatibility

Incompatibility of stored chemicals is a serious concern to prevent an accident, such as container breakage, a spill, violent weather events, or a fire. An example of an oxidizing acid being stored with a toxic liquid shown in Fig. 6-7. An effective chemical inventory system allows you to specify the types of materials that can or cannot be stored in a particular location.



Fig. 6 Chemical storage cabinet in quality control laboratory.

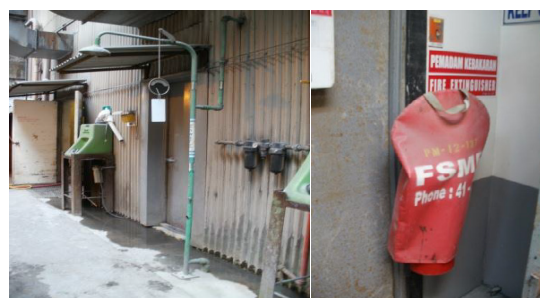


Fig. 7 Emergency eyewash, drench shower and fire alarm and extinguisher around quality control laboratory.

Flammable liquids

Ten chemical storage requirements consist of keeping quantities of stored flammable and combustible liquids within regulated limits and within proper containers. It must be stored in flammable liquid storage cabinets that listed and approved or constructed as Section 4-3 of NFPA 30, as shown in Fig. 7. In addition, there are limits on the maximum allowable size of containers based on the flammable liquid class. When a query of the field's chemical name, amounts, container type, and location was performed, the following report was generated (Table 1). Well-managed inventory system can address hazard identification, storage compatibility, hazard minimization, and flammable liquid concerns before they become issues.

Emergency procedures

Quality control laboratory are responsible to identify and evaluate the hazards, determine for appropriate emergency preparedness and response procedures,

Table 1. Regulatory compliance report list table

Regulatory Compliance Report
Storage
Cabinet painted yellow for flammable liquids
Cabinet painted blue for corrosive liquids
No more 60 gallons of flammable liquids and 120 gallons of combustible liquids in one cabinet
Cabinet doors are to be self-closing, lose fitting, fitted with three-point locking mechanism to secure the door
The cabinet is fire resistant to a minimum of 10 minutes at 325°F/163°C
The cabinet is to be ventilated and the opening is to be covered by flameproof mesh
Airflow through the cabinet is sufficient to remove any accumulation of vapors
Shelving is designed to assist with ventilated
The door sill is raised 2 inches above the bottom of the cabinet allowing all leakage to be directed to a lower containment section in the bottom of the cabinet
The corrosive storage cabinet is lined with polyethylene liner
No more than 3 cabinets are located in a single storage area
The location of the cabinet does not impede escape or evacuation in an emergency
Cabinet storage outside is positioned in protected areas away from weather and traffic damage
If cabinet is located in buildings, there is secondary egress from that building
All containers stored in storage areas have lids/caps fitted
No packing materials such as cardboard boxes and rags are stored inside cabinet
No more than 25 gallon of flammable or combustible liquids is stored outside of an approved storage cabinet, unless the storage area is designated as a temporary storage area
Symbol and Label, Signage and Notice
Maximum storage capacity signage in liters or gallon must be displayed
'Danger' or 'Watch out' warning sign must be displayed
Warning signage of 'Restricted Area, Authorized Personnel Only' must be displayed
Warning signage of 'Danger, No Smoking' within 5 meters
All hazardous material containers will be properly labelled
Safety data sheet (SDS) and inventory goods, flammable, combustible are compatible in bilingual
Compatibility chart is located on/or near the storage area
Emergency tools
The cabinet is to have sill 2 inch above the bottom contain
Spill equipment is available
Emergency eye wash/shower is to be compatible near a storage
Firefighting equipment is to be compatible with the class of goods stored

and ensure all laboratory staff aware of those procedures. Easy access and ensure to emergency equipment such as fire alarm and extinguishers, emergency eyewash stations, and showers free to accessing by laboratory staff (Fig. 7) and sisle space have to maintain to ensure that the equipment can reached. Exit signs are equipped with on auxiliary power emergency lights. Chemical Coordinator conducts evacuation drills at least once a year and should evaluate the hazards and quantities of the chemicals in use in their laboratories to determine what level of response would be required in the event of a chemical release [13]. If any incident while chemical releases, fume and/or mist can be controlled by ventilation and it maintenance will minimizing risk, some releases can pose a fire hazard or health hazard.

CONCLUSION AND RECOMMENDATION

Chemical inventory web-based programs developed

to address hazardous materials issues during chemical operations and management system can address hazard identification, storage compatibility, hazard minimization, and flammable liquid and emergency response and preparedness. Locations for containers with specificity to the shelf used to address concerning storage and chemical coordinator accountability. Chemical Hazard Identification database provides a way to take advantage of the combined expertise of the chemical coordinator.

The following actions are recommended from this research are conducting labels and signs installment on storage container which have complied the GHS requirements and system. Also, withdrawing MSDS (Material Safety Data Sheet) in each storage container to be replaced with SDS (Safety Data Sheet); repairing cabinet doors and air ventilation in order to comply with the stated standards and requirements; stored the chemical materials based on their types and

cabinet capacity; and put Hazardous Materials Placard in related to firefighting concerns.

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