ERP Spatial Management for Oil and Electric Networks

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***Abstract*—VCDM (Virtual Common Data Model) concept is used to accomplish integration between heterogonous and various workflows for enterprise organizations Virtual Common Data. The common elements between the heterogonous workflows are identified, creating SDM (Spatial Data Model) to act as the common data model based on analyzing the activities and workgroups for common processes in various workflows. Also, this paper shows how to analyze and develop the spatial data model to act as the unified geo framework for the various and heterogonous workflows in the enterprise organizations.**

Keywords-spatial asset management; location ID; spatial risk score matrix geo-framework; emergency planning zones.

I. INTRODUCTION

Williams [6] shows that many utilities in the practice of managing information remains undisciplined and unfocused. This can be seen by several aspects. It shows for example, at high costs and locked in resources associated with the development and redundant maintenance. Also, it is seen at overlapping point-to-point interfaces, an unmanaged glut of information (such as an accelerating volume and velocity of information sources) and an inflexibility of system design. All of these aspects cause a delay in response to evolving business needs. Utility IT (Information Technology) personals, engineers and operations leaders have recognized the need for asset data management. They recognize the value of enterprise GIS (Geographic Information System) as the required vehicle for asset data management.

Sami [4] presents that the major benefit to be derived from using GIS is the integration of disparate information systems, many of which already exist but which cannot communicate or exchange data effectively.

EPR (Emergency Response Planning) systems have been deployed with an overarching purpose to reduce the costs by managing processes and materials. The principal benefit of a consolidated ERP strategy was to ensure that data was not duplicated across departments, eliminating “islands of information”. Once the processes are separated, then they can now be linked, enabling the enterprise for wide planning and optimization. The changed competitive landscape will demand that ERP supports all goals regardless of their locations in an organization’s value network. Only then, enterprises can mobilize quickly and respond effectively to events as they occur at breakneck speed.

One of the main strategic objectives in the enterprise organizations is to develop the media, which can be used to analyze and show the impact of various and heterogonous workflows for achieving the scope with minimum time and cost and most attainable quality. VCDM is the approach which we will follow. Creation of VCDM is very challenging when we want to see the impact of completely different management plans within the organization. The following different systems and plans (impact of engineering system, field’s development system, exploration system, human resources and training management plans) have effects on each other. Combining the data from these systems will enable the user to reach the strategic organizational objectives. This challenge could be resolved through the SDM concept.

SDM concept is based on management and analysis of heterogeneous workflows through the spatial integrity in GIS environment. SDM relies on spatial modeling and analyzing workflow work packages or activities for planning, monitoring and controlling process for various business workflows. Analysis and implementation of workgroups of common processes for various workflows are more scalable and accurate than relying on common elements. It is difficult to identify the common elements among the heterogonous workflows, whereas analyzing the activities of processes common among these workflows could overcome this issue.

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The state of the art is to form the SDM model. This SDM model will overcome the complexity of the existing approaches. It reduces maintenance and operation costs. Also, the responses are fast .

The critical point in SDM approach is creation of the spatial correlation between the analyzed and decomposed activities. The most efficient approach is forming the spatial risk data model. The decomposed work groups from various workflows can be spatially analyzed and managed, and then correlated using spatial risk data model. This paper presents a method to show how GIS can be utilized and managed as a unified geo framework through the development of spatial data model for ERP (Emergency Response Plan) for Oil and Electric Networks. The first section in this paper is about the spatial management of ERP for H2S (Hydrogen Sulphide) dispersion. The second part is about the spatial model of electric power networks in risk assessment management.

II. GIS AS UNIFIED GEO FRAMEWORK FOR EPZ (EMERGENCY PLANNING ZONES)

This case involves finding the shortest and the least cost path for Hydrogen Sulphide pipe line by constructing the proper models needed. Spatial risk score matrix is being developed. Different and needed zones are determined. These obtained data are fed to GIS system to find the targeted spatial model for the study case.

A. Objective

The goal is to implement spatial risk model derived from H2S (Hydrogen Sulphide) dispersion model to be the foundation of ERP management in GIS (Geographic Information System).

B. Scope

The scope is to create dispersion risk model for H2S derived from EUB (Energy and Utility Board) dispersion calculation model. Then, calculated EPZ (Emergency Planning Zones) spatially for sour wells based on phase operation is implemented. Wind magnitude and direction impact in case of calculated protective action zone are considered..

Capability of creating actual EPZ zones is based on geospatial analysis relationships. These zones are recognized with respect to the available geographic objects. For example, these objects can be the access routes and their availability..

Implement the spatial risk assessment score matrix per sour well to enable the spatial management of ERP type related to the well based on its status.

C. Proposed spatial data model for ERP management based on the spatial risk model

Figure 1 shows the proposed spatial ERP data model based on the developed spatial risk model derived from the defined spatial and non-spatial probable parameters as well as the related consequence analysis for H2S dispersion through which the emergency level could be specified as well as related ERP modules. Different factors related to the spatial situation in question is being taking care off. Figure 2 shows proposed flow chart of spatial ERP management based on EPZ consequence analytical zones.

D. Customized spatial risk model using python script in ESRI environment

The data needed are being gathered. These data are being put in the proper form for ESRI computer software environment. Figure 3 shows the customized GIS model used to extract the main output parameters from the calculated EUB (Energy and Utility Board) for H2S calculation model. Such parameters are the calculated EPZ (Emergency Planning Zone), PAZ (Protective Action Zone), IIZ (Initial Isolation Zone) distances, H2S concentration, wind magnitude, phase operation, and other mandatory parameters to be accounted for in the spatial risk model.

E. Create spatial risk model

This model will indicate the amount of risk involved depending on the probability analysis needed. The spatial EPZ, PAZ, IIZ per analytical asset or element (sour well) is being created. Then, the spatial risk model can be obtained based on EPZ consequence analysis and the defined impact parameters.

Figure 4 shows the initial output of the spatial risk H2S dispersion model based on the calculated EPZ zones from EUB for H2S dispersion model, as well as the creation of initial spatial risk model.

F. The final resized EPZ, PAZ, IIZ with the modified spatial risk model

The final spatial model will detect and adapt to changes. Figure 5 shows how the spatial model is intelligent enough to detect any change in the defined risk parameters whether spatial, environmental (e.g., wind direction and magnitude from sensors, etc.) or non spatial risk parameters (e.g., uncontrolled flow, etc.) and adapt accordingly.

III. ILLUSTRATIVE EXAMPLE FOR SPATIAL DATA MODEL OF ELECTRIC POWER NETWORK

This case presents how to find the shortest and the least cost path for electrical line by obtaining the proper models needed. The spatial location ID code consists of the following needed codes: Utility code - Province code - City code - District or village code - Distributer code.

A single line diagram shown in Figure 6 is composed of five medium voltage cells. It shows two incoming cells, two outgoing cells, and one bus tie cell. Each cell is controlled and protected by one medium voltage circuit breaker and two isolating switches.

The spatial location ID shown in TABLE I provides the operator with the illustrative specific location of each element of the concerned network starting from the electric

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distribution company to the concerned element i.e., distribution board, in each cell, etc.

Each of the geographic area or sites or department belonging to the concerned electric network are shown in TABLE II provided with the code of each of them.

IV. EQUATIONS FOR SPATIAL RISK SCORE MATRIX DEVELOPMENT AND ERP SPATIAL MANAGEMENT

In this section, the needed and used mathematical formulae are being presented. The zones EPZ, PAZ, IIZ are created for each case study based on the evaluated consequence analytical values:

1) *Refined EPZ radius = EPZ calculated (1 + Related consequence value).* [1] [2].

The actual EPZ is calculated based on the impact of spatial and non-spatial parameters on the consequence matrix.

2) *(Total Of Risk) TOR = (Probability * Consequence) per asset or analytical element.* [1] [2].

The total of risk score per asset(object). This value is inserted into the risk score matrix for risk evaluation.

3) $$f(x) = \frac{1}{\sqrt{2\pi\sigma}} e^{-(x-\mu)^2/2\sigma^2}.$$ [4]

Binomial distribution equation: that represents the probability relationship between the quality performance and related risk. This equation is used for the calculation of quality performance indicator of the target plan.

where $\mu = \frac{TOR}{2}$,

and $\sigma = \sqrt{\frac{TOR^2}{4}}$

X = 1 (Assumed Random Variable)

Scale Factor = 100 (Assumed)

4) *QPI (Quality Performance Index)* $= f(x) \times 100$

QPI of target plan is calculated assuming that the scale factor is 100.

V. CONCLUSION

In this paper, the role of spatial model is being applied to obtain integration between various workflows. The concept of VCDM (Virtual Common Data Model) concept is used. The SDM (Spatial Data Model) is created to act as the common data model based on analyzing the activities and workgroups. Spatial analysis for the decomposed workgroups within common processes is proved to be more manageable and scalable than relying on common elements in the development of the domain spatial data model. The obtained spatial model is dynamic and robust.

VI. REFERENCES

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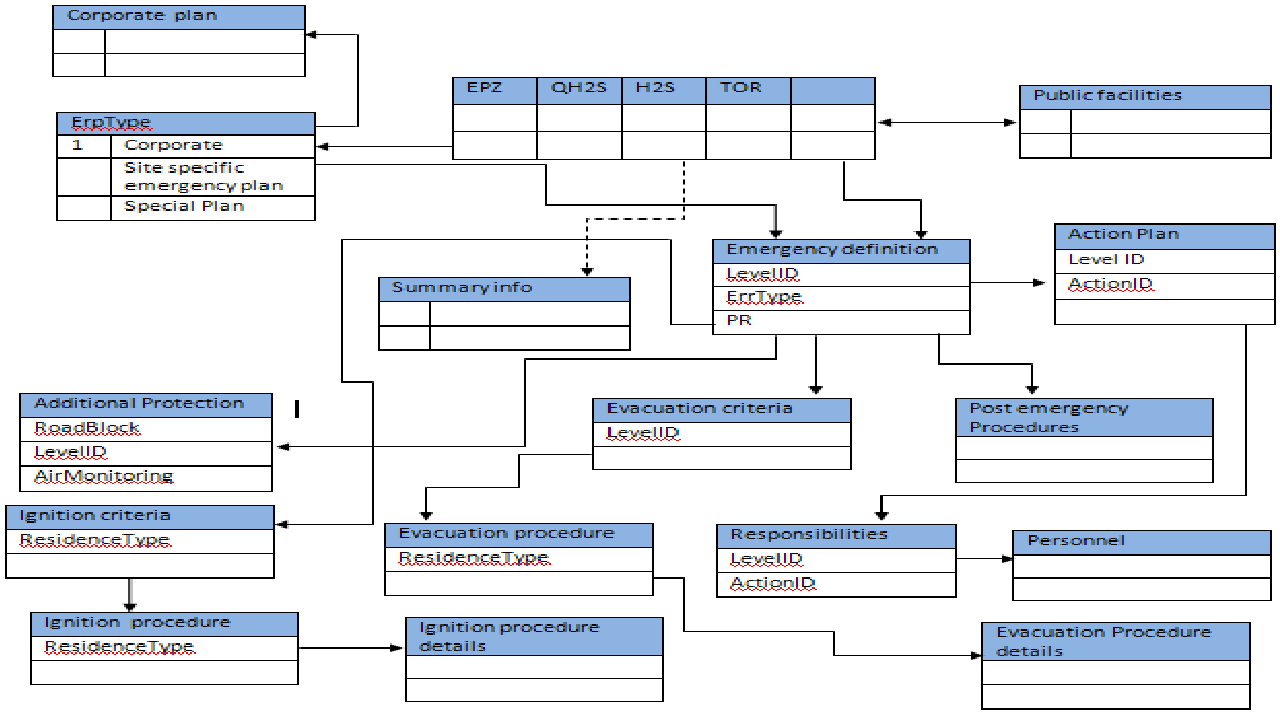

Figure 1. Example of spatial ERP data model in GIS environment.

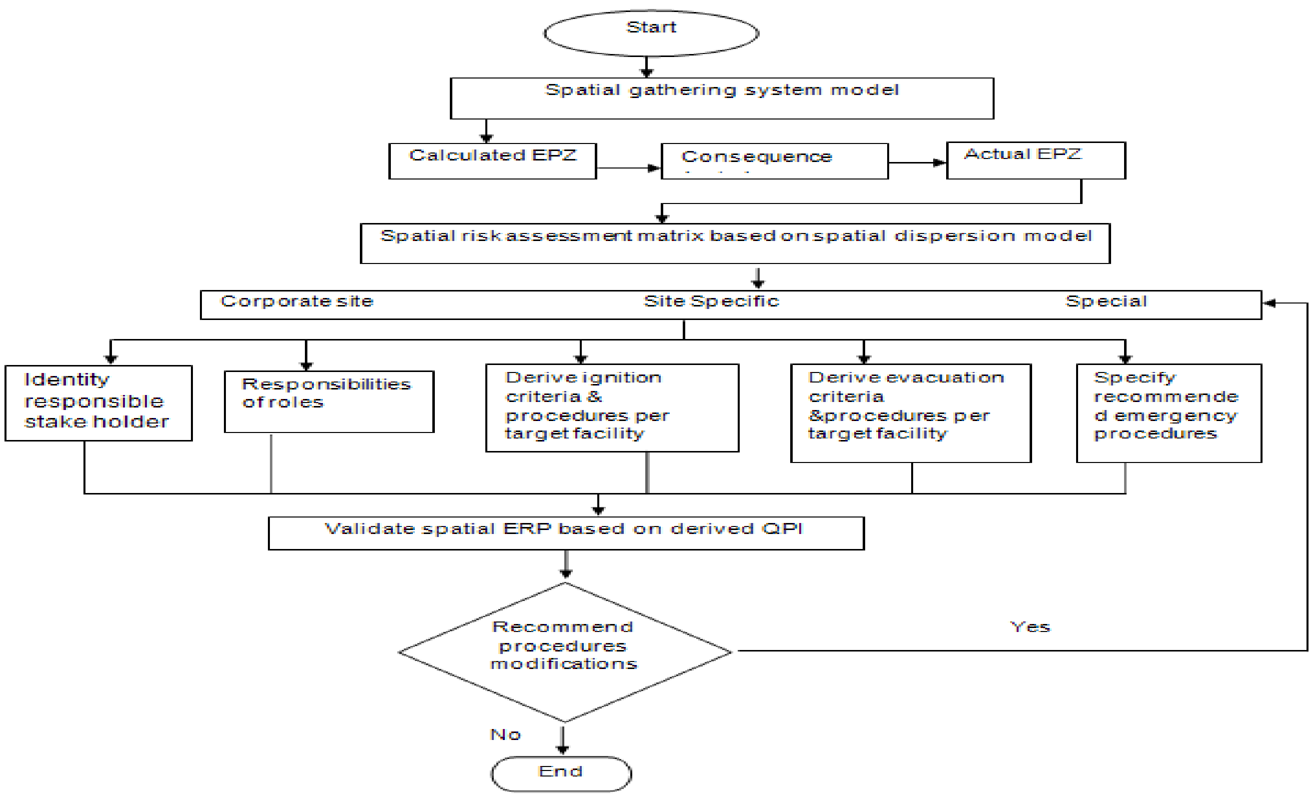

Figure 2. Proposed flow chart of spatial ERP management based on EPZ consequence analytical zones.

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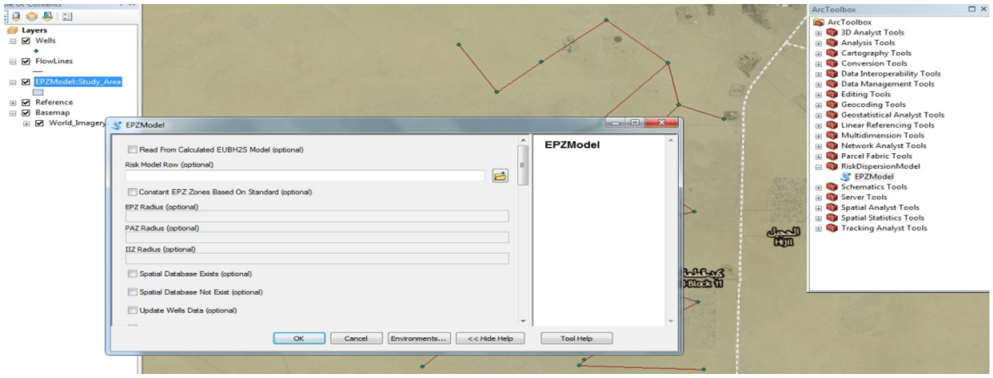

Figure 3. The model interface of spatial H2S dispersion model.

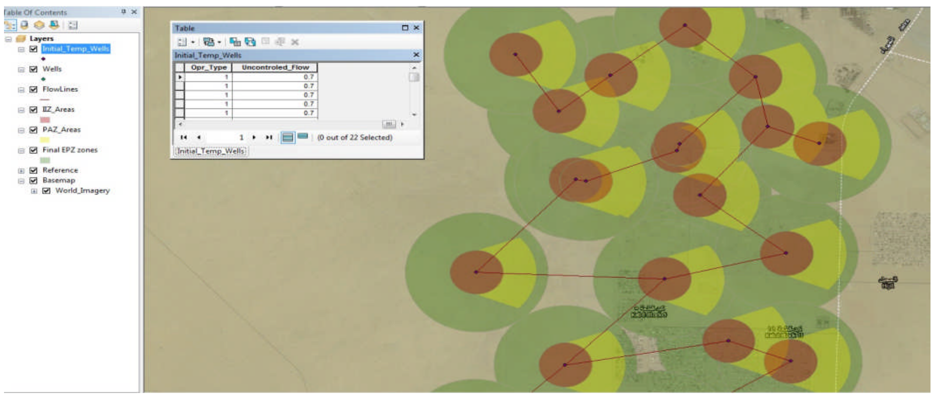

Figure 4. The calculated spatial EPZ zones.

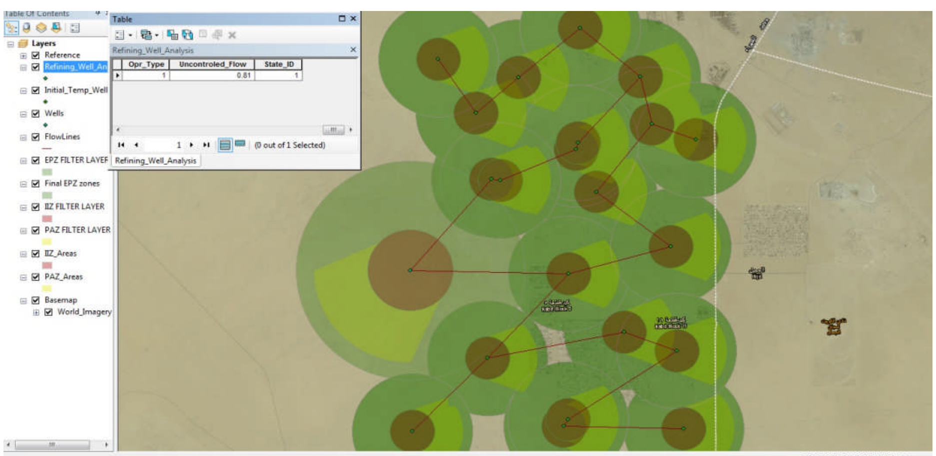

Figure 5. The refined spatial EPZ zones.

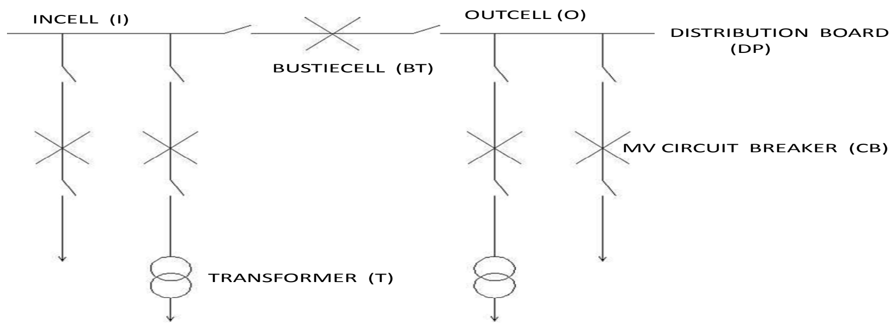

Figure 6. Single line diagram of Distribution Board (DB)

TABLE I. SPATIAL LOCATION ID CODE OF ELECTRIC POWER NETWORK.

No.	Item Name	Location ID
1	Distribution Board (11.0 & 22.0 KV)	6/1/02/DP05
1.1	In Cell	6/1/02/DP05/I1
1.1.1	MV Circuit Breaker (11.0 or 22.0 KV)	6/1/02/DP05/I1/CB1
1.2	Out Cell	6/1/02/DP05/O1
1.2.1	MV Circuit Breaker (11.0 or 22.0 KV)	6/1/02/DP05/O1/CB1
1.3	Bus Tie Cell	6/1/02/DP05/BT1
1.3.1	MV Circuit Breaker (11.0 or 22.0 KV)	6/1/02/DP05/BT1/CB1

TABLE II. GEOGRAPHIC ELEMENTS CODE.

Name	***Code***
Electricity Distribution company	6
governorate	1
district	02