An Expert System Portal for Environmental Health and Safety

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Abstract: - In this paper definition and technical details of E3P Enviromental Pollution Preventation Portal has been explained. The scope of the E3P Expert System is to develop an information management, sharing and controlling system, or simply an environmental pollution portal. The portal aims for collaboration, information sharing, record tracking, management of the issues for sustainable environmental health and safety. One of the major roles of the system is tracking of legal issues, coordination between different bodies such as private companies, governments, ministry of environments, and municipalities.

Key-Words: - EHS, Expert System, Information System, Portal, E3P

1 Introduction

Over millions of years ago plants covered the earth, converting the energy of sunlight into living tissue, some of which was buried in the depths of the earth to produce deposits of coal, oil and natural gas. During the past few decades has found many valuable uses for these complex chemical substances, manufacturing from them plastics, textiles, fertilisers and the various end products of the petrochemical industry. Each decade sees increasing uses for these products with a increase in the environmental pollution.

Industry's use of fossil fuels has been blamed for our warming climate. When coal, gas and oil are burnt, they release harmful gases, which trap heat in the atmosphere and cause global warming. However, there has been an ongoing debate on this subject, as scientists have struggled to distinguish between changes, which are human induced, and those, which could be put down to natural climate variability. Industrialised countries have the highest emission levels, and must shoulder the greatest responsibility for global warming. However, action must also be taken by developing countries to avoid future increases in emission levels as their economies develop and population grows. Human activities that emit carbon dioxide (CO2), the most significant contributor to potential climate change, occur primarily from fossil fuel production. Consequently, efforts to control CO2 emissions could have serious, negative consequences for economic growth, employment, investment, trade and the standard of living of individuals everywhere. Scientifically, it is difficult to predict the relationship between global temperature and greenhouse gas (GHG) concentrations. The climate system contains many processes that will change if warming occurs. Critical processes include heat transfer by winds and currents, the hydrological cycle involving evaporation, precipitation, runoff and groundwater and the formation of clouds, snow, and ice, all of which display enormous natural variability. The equipment and infrastructure for energy supply and use are designed with long lifetimes, and the premature turnover of capital stock involves significant costs. Economic benefits occur if capital stock is replaced with more efficient equipment in step with its normal replacement cycle. Likewise, if opportunities to reduce future emissions are taken in a timely manner, they should be less costly. Such flexible approaches would allow society to take account of evolving scientific and technological knowledge, and to gain experience in designing policies to address climate change. [1]

EU-27 Member States and Candidate Countries dealing with different policies in different countries and regions. However all the countries have internal mechanism for pollution and environmental monitoring due to with some shared information with the EU. The main EU policy documents and directives which have impact on sustainable energy development are directives promoting energy efficiency and use of renewable energy sources, directives implementing greenhouse gas mitigation and atmospheric pollution reduction policies and other policy documents and strategies targeting energy sector. Promotion of use of renewable energy sources especially biomass and energy efficiency improvements are among priorities of EU energy policy because use of renewables and energy efficiency improvements has positive impact on energy security and climate change mitigation. The directives targeting energy efficiency, renewables and climate change mitigation indicates the EU energy policy priorities: reduction of energy impact on environment,

improvements in energy generation and energy use efficiencies, increase in reliability and security of energy supply, promotion of renewables use and climate change mitigation. All these directives have specific targets which can be addressed by quantitative indicators. As targets set by specific directives are related the use of interlinked indicators framework to address these targets can be useful tool for energy policy analysis and monitoring. Such tool applied by EU member states can help to harmonize EU energy policies and enhance its implementation on country level.[2]

Scientific and engineering disciplines seek new techniques to solve problems, which cannot be solved by currently available methods. A transition from deterministic to stochastic or from procedural to heuristic methods is used recently to tackle various problems. In this connection, Artificial Intelligence (AI) techniques including expert systems (ESs), artificial neural networks (ANNs), fuzzy logic, etc., became attractive worldwide. Perhaps, ESs are among the most fertile areas for scientific research in the field of AI. ES solutions are based on reasoning by using problem domain knowledge and heuristics. Hence, ES approach is the most suitable methodology for simulating human experts. Most of the ESs for ship design is aimed at development of assistance to deal with the complex characteristics of design problem.[3]

2 E3P Expert System

E3P Enviromental Pollution Preventation Portal is a hybrid application takes the goods of the many intranet and internet based information sharing system. The portal aims for collaboration, information sharing, record tracking, management of the issues for sustainable environmental health and safety. One of the major roles of the system is tracking of legal issues, coordination between different bodies such as private companies, governments, ministry of environments, and municipalities.

Since environmental issues have lots of related sides. E3P system groups these sides according to their responsibilities, affects and their sufficiency of knowledge/judgment on environmental issues. These user groups are concentrated in to four major groups.

2.1 System Users

These are the actual users and organizations directly associated with the environmental issues. (Factories in production sector, SEM's, big commercial buildings, hospitals, education centers and other bodies that are related to public environment.) In other words these are the customers of the system without paying money. System users also leveled into minor groups like

- Visitors : System users, using the system without registration just for information taking
- Lite Users : System users registered as limited responsibility and tracking. Such as a SME with limited production and pollution.
- Professional Users : These are the legally forced users of the system with the local or international authorities. The real actors of the game.

2.2 Measuring & Auditing Bodies

These are the measuring and auditing of users and rules by means of their responsibilities (universities, laboratories, bodies and expert companies). These users aid and support the System Users for their experimental and technical issues. Its so obvious that most the factories and production facilities don't have adequate equipment for environmental monitoring and reporting.

2.3 Overseeing Bodies

Municipality and other public institutions which permit users for production and also controlling them through law and regulations. These bodies also have some sanctions over users. In other words these users are the monitoring and tracking body of the system with the definitions of the laws, acts and regulations made by the next group.

2.4 Bodies Issuing Rule and Regulation

Regulators and law makers of Environmental Health Safety and Energy related issues. Such as Department of Environment, Department of Energy and Department of Health, World Health Organization, World Environment Organization. These users sets and define the limits of the playground or the business in their responsibility area. Some of these users work together with internal agreements.

3 Overview of the System

The issue of environmental protection is among the most important problems society as a whole is facing at present. The problem arose due to a social constitution in which production, consumption and waste disposal are done on a large scale. To solve the problem, it will be essential to change the social constitution to one in which environmental consciousness predominates. This will be achieved when substantial numbers of individual groups, including manufacturers, consumers, recyclers and waste managers incorporate environmental consciousness into their actions, e.g. manufacturers offer environmentally conscious products with low environmental impact, mass consumers show a preference to purchase "greener" products, recyclers recycle used products efficiently and waste managers treat waste in a proper and appropriate manner. [4],[5].

The E3P system works on the Internet and also on Intranet and can be used cooperatively between the mentioned groups above. Users can also use this system as an internal control mechanism for their companies. As a result of this efficient time use, synchronous studies can be done worldwide.
Global servers can be used to reduce the software and hardware implementation within the world. Software architecture is developed for high performance, scalability and modularity.
Mobile device application is used for greater mobility, since the definition of the environment has no limits simply anywhere surrounding us. Depending on the job and duty of the active groups mobile applications are used.
Working principle of the systems is based on the synchronous working of four above mentioned groups in the world anytime anywhere. By using this system alterations and actions of Rule and Regulation Issuing Bodies can be followed by all other related groups within seconds. As a result of this, users can take some improving actions to obey the new system and the Overseeing Bodies can examine the affected users and their new responsibilities within their region.
The system works as an "Expert System" with a roadmap database for every sector which allows the users to understand and determine their responsibilities and actions that should be realized. Same subjects also defined by related Overseeing Bodies which help them to overcome the disagreements between them and the users. Moreover, users can define custom regulations depending on the local government, company policies, and regional standards. So HCI (Human Computer Interfaces) intuitive, ergonomic and user friendly even for non-educated people. What they have to do is to select the job and business description from the list, the rest of the system does not need a chemical or environmental expertise.
As an example, a company A, enters the systems and ask for the regulations for Air Pollution or Water Pollution. The Expert System asks for the type of the standards that the company wants to apply such as International, National, Regional or Custom. Company can select more than one standard and how to track that standards such as follow, obey, publish online to public or publish to authorities only. After selecting the standards, the systems add the responsibility items for the selected issue and asks for the related employees for internal alert system.

If the selected issue needs technical reporting based on the experiments, sampling or laboratory work, the system offers the potential Measuring & Auditing Bodies depending on the regulation. The users can contact with them or opens a bid for the related reports. This is the B2B part of the system. Measuring & Auditing Bodies are certified according to their capabilities by proper registration and certification system such as ISO standards.

The major innovation with this system is to combine and collect the whole world in one structure. The database structure allows different users define international and national responsibilities, laws, acts and regulations to the system.
Overseeing Bodies, Rule and Regulation Issuing Bodies use the system as an announcement system. In the beginning most parts of the systems work voluntarily, but for the parts which are protected according to the international and national laws, acts and agreements overseeing bodies and measuring and auditing bodies are informed by the system about deadlines and the actions to be done before deadlines. This system helps to reduce the friction and disorganization in the sector.
For instance, a user who is responsible for Chimney Gases and Emission reports can obtain the specifications, limits, responsibilities, law and regulations and report/doc frequencies after entering their information about factory, production, process and heat generation unit. After obtaining these data, users can search for Measuring & Auditing Bodies available within the system. After working with Measuring & Auditing Bodies, reports and legal documents, some documents will be prepared.
Overseeing bodies such as municipality and other public institutions reach the same data at the same time and make the necessary actions.
Since environmental health concerns with the followings, E3P Expert system can store data and information about the environmental health addresses all human-health-related aspects of both the natural environment and the built environment. Environmental health concerns include:

- Air quality, including both ambient outdoor air and indoor air quality, which also comprises concerns about environmental tobacco smoke.
- Climate change and its effects on health.
- Disaster preparedness and response.
- Food safety, including in agriculture, transportation, food processing, wholesale and retail distribution and sale.
- Hazardous materials management, including hazardous waste management, contaminated site remediation, the prevention of leaks from underground storage tanks and the prevention of hazardous materials releases to the environment and responses to emergency situations resulting from such releases.
- Liquid waste disposal, including city wastewater treatment plants and on-site waste water disposal

systems, such as septic tank systems and chemical toilets.
- Medical waste management and disposal.
- Noise pollution control.
- Occupational health and industrial hygiene.
- Solid waste management, including landfills, recycling facilities, composting and solid waste transfer stations.
- Toxic chemical exposure whether in consumer products, housing, workplaces, air, water or soil.

4 Structure, Technology & Add-ons

An expert system is a computer program that represents and reasons with knowledge of a specified subject with a view to solving problem directly or giving advice. [7]
E3P system based on development for interoperability and easy use of the system. In order to obtain flexible and adaptive expert system and a portal for all kind of users and organizations whole system developed as a modular programming structure with add-ons. According to this structure there are some common modules for every user with customized properties . And add-ons for more specific and custom needs of the users and the related area.
Common modules are

- User interface—the mechanism by which the user and the ES communicate and share information. User interface is designed and programmed as a web application so an ordinary internet user computer is sufficient to use the system
- Explanation facility—explains the reasoning of the system to a user.
- Inference engine—makes inferences by executing rules which are satisfied by facts or objects according to a priority scheme.
- Agenda—a list of rules by the inference engine, whose patterns are satisfied by facts or objects in working memory.
- Automatic knowledge acquisition facility—an automatic way for the user to enter knowledge in the system rather than by having the knowledge engineer explicitly code the knowledge.
- Knowledge-base—consists of two parts, the domain knowledge, which represents some rules about the problem domain, and working memory where facts and generated facts are hold.
- Ranking system for countries, cities and companies according to their data submissions and volunteer actions showing how green and environmental respectful they are.
- Popfly gadgets used for alerting and reminder system for the active users.
- Document management system for technical reports, ISO certificates, testing equipment outcomes and reports and experiments.

Sub applications and add-ons for the system are,

- RFID Identification System for the Users to avoid unlawfulness and misuse of authority. RFID passive tags used for labeling the factories and should be read according to visits of regulatory bodies. This overcomes the problems of writing reports and making experiments without visiting the facility.
- Synchronization with GPS for Factory Location Approval
- Online measuring and communication via web service to the global servers. Global server database includes the industrial standards and device definitions within the system. So test device manufactured can define their communication packages depending on the data sequence. Users can define their equipment on the site and these devices send their data over standard communication ports for globalization according to their responsibilities and public awareness.

5 Globalization and Application

E3P Portal starts with the idea of "One Planet Many People" which claims that we are sharing one planet with many people. The idea behind is if someone polluting the environment in any part of the planet, this will effect the rest sooner or earlier. This project aims to develop a global awareness and auto control for sustainable environment by the use of technology.
One other responsibility of the project is to collect the statistical information which will be useful for government bodies such as Department of Energy, Department of Health, Department of Environment and other world organizations.
Regional and national statistical data can also be collected from the system which helps making macro decisions and policies and academic researches

6 Technology

Conventional expert systems are PC based and are not of much use where the expertise is required over a large network. The advent of the internet has strongly influenced modern power systems. A web based expert system is an apt solution for such environments. [8]
Service Oriented Architecture is used as architecture model based on ASP.NET 3.5 web services. This architecture provides all benefits of web services like location independence, interoperability, flexibility and modularity. All information is processed using web services so different users from different platforms and

different users can obtain registration data, reports and to do lists easily.

7 Conclusion

E3P portal and expert system is just a tool for human beings to help and support them to protect and save the environment. It has nearly all of the nowadays and near future need of the different bodies dealing with the environment. However its just a tool, without interaction and afford it will remain as a tool with no support for Environmental Health and Safety. In the beginning the system starts as a voluntary membership but in the near future it will become a must. Its so sad but true that for a factory or a production facility to act according to the limits and regulation means less profit and loss on money. E3P Expert System supports the foundation of global balance within these groups for facing with the same economical conditions.

References:

[1]Omer, A.B., Green Energies and Environment, *Renewable and Sustainable Energy Reviews*, 12 (2008) 1789–1821

[2] Dtreimikienea, D., Šivickasb, G., The EU sustainable energy policy indicators framework, *Environment International,* (June 2008)

[3] Helvacioglu, S., Insel, M., Expert system applications in marine technologies, Ocean Engineering 35 (2008) 1067– 1074

[4] J. Fujimoto, R. Ugo and J. Kimura, Environmental Total-Solution System for New Era Production, *Proceedings of International Conference on EcoBalance*, 1994, pp. 61-67

[5] S. Miyamoto, T. Tamura and J. Fujimoto, ECO-Fusion, Integrated Software for Environmentally-Conscious Production, *IEEE International Symposium on Electronics and the Environment*, 1996, pp. 179-184.

[6] Jain, M.B., Srinivas, M.B., *A Web based Expert System Shell for Fault Diagnosis and Control of Power System Equipment*, 2008 International Conference on Condition Monitoring and Diagnosis, Beijing, China, April 21-24, 2008

[7] Swarup, K.S, Chandrasekharaiah, H.S., *Diagnostic Reasoning Based On Structure And Behavior*, Conference: Power System 2000

[8] Incorporating Expert Systems into web based environment, from proceeding (385) Artificial Intelligence and Soft computing-2003