BESTCITY: DEVELOPING CLEAN CITIES

By Intelligently Management of Information

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Abstract: Artificial Intelligence applications have immense potential to fill the knowledge gaps that exist in developing countries. During the past decades, many AI applications have developed to solve structured problem domain and less concern about complex problem domain such as solid waste management. Hence, solid waste management is a burning environmental issue in developing countries due to lack of expertise and information assimilation paths. To fill this knowledge gap a user-friendly decision support system (DSS), BESTCity is developed. This paper describes the techniques used for the development stage and robustness of BESTCity DSS. Much evident clean cities in developed economies with the huge amount of knowledge available could be intelligently managed to solve issues in developing countries, which is the main objective of BESTCity.

Key words: Knowledge-based system, Decision Support System, Solid Waste Management

1. INTRODUCTION

During the past decades, many Artificial Intelligence (AI) Applications have been developed and successfully used in different fields. In literature, it is highlighted that expert systems in environmental engineering have appeared after fifteen years after the first expert systems were pioneered. One key reason for the delayed involvement was that the behaviour of environmental processes was not well understood and environmental science is of multidisciplinary nature. Furthermore, it is often need to involve

chemists, geologists, toxicologists, microbiologists and experts of other disciplines (Basri and Stentiford, 1995). Solid Waste Management (SWM) is also such a difficult problem domain to develop AI applications because of its complexity and being a politically and an emotionally charged issue.

Today, in most developing countries like Sri Lanka, SWM has become a grave problem due to knowledge inertia, scarcity of expertise, stagnant knowledge sources and use of routine problem solving procedures. Thus, Rubenstein-Montano (2000) stated that solid waste planning is also a problem domain well suited for a knowledge-based approach. It has been proved by developing AI tools such as Decision Support Systems (DSS) to assist waste planners since 1940s (McHenry et al., 2002). As access to human experts at the field and operational levels is not always easy in developing countries, particularly in rural cities, it is clear that AI tools can be used to assist in filling the knowledge gaps that exist in the SWM hierarchy. However, Wilson's (1981) review showed that no completely satisfactory modelling approach was available, and concluded that such models offer little scope for further development as practical aids to waste management planning (Basri and Stentiford, 1995). In literature, it is found that past developments have been concerned as a series of small problems such as routing, processing, disposal, marketing etc without considering the relationship between each. McDougall (2001) emphasised that integrated waste management takes an overall approach to waste management, it combines a range of collection and treatment methods to handle all materials in the stream in an environmentally effective, economically affordable and socially acceptable way. Hence, this research focused on developing a DSS, BESTCity to assist decision makers and solid waste planners to run an effective integrated SWM system.

2. METHODOLOGY

2.1 Problem Identification

Problem domain is identified as flow-through systems in various stages such as waste collection, recycling, treatment, and disposal. All the problems were thoroughly analyzed and the knowledge required is clearly identified by doing case studies. Imported elements of integrated SWM such as the concept of 3R's (reduce, reuse, recycling) have been included.

2.2 System specification & development tool selection

As programming the inference engine is laboriously time-consuming, a commercially available high-level expert system shell, Acquire® 2.1 is used for developing the decision support tool. Acquire® was selected as system development tool as it provides a step-by-step method for acquiring and structuring knowledge that lets developer without programming skills develop knowledge-based applications. Such direct involvement by subject matter experts improves quality, accuracy and usability and lowers development and maintenance time and cost (Internet,1). Acquire SDK is used to develop applications with custom user interfaces, to create additional computational functionality for Windows and to deploy Acquire knowledge bases in a user environment.

2.3 Knowledge Acquisition

Even though here is no formal methodology, which is applicable universally for knowledge acquisition, it is the main bottleneck during the development of the AI tool, not because expertise in the field is scarce but also ‘paradox of expertise’. They look at the problem in different ways and suggest different solutions. The techniques to elicit and acquire knowledge are shown in figure 1. Dynamic data mining is a significant research activity in itself.

2.4 Knowledge Representation

A knowledge representation (KR) is most fundamentally a surrogate, a substitute for the thing itself, used to enable an entity to determine consequences by thinking rather than acting, i.e., by reasoning about the world rather than taking action in it (David et al., 1993). In BESTCity DSS, knowledge representations including production and action rules, cases, reports and objects are being utilized. It can provide a qualitative representation of tacit assessment knowledge (Mitri, 2003).

3. BESTCITY FOR ISWM

The national strategy for SWM introduced by the Ministry of Forestry and Environment in 2000 for Sri Lanka for sustainable waste management emphasizes the need to minimize waste production, increase waste recovery and reduce the use of landfill (NSSWM, 2000). The aim of developing

Figure 1 : Knowledge Acquisition Techniques used for BESTCity DSS

BESTCity DSS to provide expert knowledge to implement national strategy as Local Authorities typically lack knowledge, information, resources and expertise.

As solid waste management is a complex problem, one problem is chosen for the initial prototype development. The performance of developed BESTComp prototype expert system demonstrates the usability of a knowledge-base tool for integrated solid waste management. BESTCity DSS is embedded with sub-modules such as BESTComp, BESTBio, BESTFill, BESTCycle, BESTTherm, BESTMove and BESTPractices. BESTComp is to guide how to make quality compost. BESTBio is to fill the knowledge gap of anaerobic digestion. BESTFill will address issues that can arise from landfilling site selection to landfill closure. BESTCycle is a info desk which provides recycling opportunities and linkages among manufacturers. BESTTherm will guide incineration processes. BESTMove enables decision makers to allocate trucks from waste collection points to disposal site so as to reduce travelling cost covering basically the logistic aspects of waste collection and transport. BESTPractices is a compilation of success stories, lessons learnt and so on, for drawing ideas for better design when implementing SWM systems. In this manner, each module clearly

defined within a narrow domain and has available sources of expertise for solid waste management hierarchy.

Graphical user interfaces are certainly more use-friendly than command language interfaces (Virvou and Kabassi, 2004). Further more, Mitri (2003) highlighted that natural language and speech understanding front ends improve query tools for knowledge management systems. Hence, the BESTCity DSS interface is designed to include the specific features of changeability, traceability, plenitude, and qualitative description. To make the computer as easy for the user to operate as possible, the BESTCity offers the capacity to interact with the system through text, pictures and graphics.

4. BRIDGING THE COMMUNICATION GAPS

Even though DSSs' contain enormous amount of information and knowledge, many decision makers and users in rural areas of the developing world will be denied the benefits of DSSs, if the information is available only in English. It is necessary to consider the wide range of users and their cognitive capabilities (Mikolajuk and Gar-On-Yeh, 1999). Decision-making using DSS occurs in all countries and is undertaken by people who are not necessarily fluent in any language other than their mother tongue (Hall, 1999). However, Lee et al., (2005) argued that decision support systems could be used to provide the right knowledge in the right form to the right persons at the right time. Hence, AI tools in local languages can make a significant impact on rural local authorities and other users. When users can get the required information in their native language, it would naturally motivate them to seek the powerful benefits of knowledge-based tools. The BESTCity DSS is embedded with multilingual natural language interfaces that users can formulate queries in their native languages.

5. SINHALA - ENGLISH ENVIRONMENTAL GLOSSARY

Even though the majority of people in Sri Lanka (79% of the population is Sinhalese) communicate in the Sinhala language, there is a remarkable absence of Sinhala lexicon for the technical and scientific words. Therefore, in order to ensure wide use of the BESTCity DSS, a Sinhala- English environmental glossary has been developed. The glossary consists of more than 1000 technical and scientific words, which are related to solid waste management. It describes each word both in English and Sinhala languages.

One of the principal impediments encountered while selecting the font in developing the glossary, is the lack of a standard Sinhala (or Tamil) font (character encoding). Although there are many Sinhala fonts available, none of them are ubiquitous (Sri Lanka – Country Report, 2003). Thus, the freely available “Dimuthu” font (Internet, 2) is selected for Sinhala language interface development (Figure 2).

Figure 2 : Dimuthu Font

6. CONCLUSION

As technology does not always need to be high-end state-of-the art technology, in this research AI applications are used in simple user-friendly ways, keeping the end user, the Local Authority, and its technical capabilities in mind. This research covers both the extraction of information from knowledge bases (including active computer systems such as expert systems) and manipulation of information (to solve particular problems or to present data in an easily comprehensible manner). Thus, BESTCity is not only a decision support tool but also a training tool for novices.

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