An Exploratory Assessment of the Use and Benefits of ESDLC in Practice

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The importance of Expert Systems (ES) as a powerful business tool has become widely recognized in industry. That in turn has led to a major increase in ES development activities and has exacerbated the need to manage these activities for more efficient use of development resources. An important component for effectively managing ES development is an Expert System Development Life Cycle (ESDLC). Based on ES development managers’ opinions, this study ascertains the general benefits to be expected from an ESDLC, integrates existing ESDLC models into one expected to be widely accepted in practice, and uses this standard ESDLC to explore what is being done in practice in terms of company specific ESDLC phases/activities and the percentage of time ES developers spend in each phase.

Background

The use of expert system (ES) technology has grown immensely in the past few years. A survey of business literature shows that very few industries (if any) have not benefitted from the use of ES, and the variety of applications within some industries is also very impressive (Ignizio, 1991). Given what has been reported in the literature, one may easily conclude that ES represents one of the most successful computer application areas to date. As a result, many large companies have established special groups dedicated to the development of ES. Several organizations have developed hundreds of individual ES, some of which have cost hundreds of thousands and even millions of dollars to develop (Lu & Guimaraes, 1989).

As a company’s investment in ES development resources increases, so does the likelihood that the activity will attract management attention and greater demand for efficient use of these resources. Further, there is widespread agreement that for large system development projects of any kind, managerial control becomes necessary to reduce risk of development and/or implementation failure, and that a systematic approach to development is essential (Khan, 1992). However, today ES development is known to suffer from a limited methodological base where ES are often constructed in an ad hoc manner (Blackman, 1990). Commonly, ES implementation is attempted directly from the knowledge acquisition stage, bundling enquiry, knowledge specification, design and development all into one phase (Plant, 1990; Rodger & Edwards, 1989).

The Need For An Expert System Development Life Cycle (ESDLC)

While ES development methodologies may be important due to the many benefits promised in the literature, ES differ in several ways (Yoon, Guimaraes & O’Neal, 1995) from traditional systems such as Transaction Processing Systems (TPS) and Decision Support Systems (DSS):

- ES perform primarily symbolic processing, whereas traditional systems perform mostly numeric processing. Suc-
successful ES development and operation depend primarily on access to knowledge rather than on ingenious computational techniques (Duda & Shortliffe, 1983). They are particularly applicable when the problem cannot be solved with an algorithm.

- ES can solve semistructured or unstructured problems using heuristics; traditional systems are ill equipped to do so.
- ES are typically developed to solve knowledge-intensive problems often to gain competitive advantage, whereas traditional systems generally focus on data and information intensive areas.
- ES can often explain the logic used to arrive at a particular answer.
- In TPS the emphasis is on well-defined information flows and hierarchical relationships in an organization which can be represented with tools such as hierarchy charts along with data flow diagrams. In contrast, ES deal with imprecise, often uncertain condition-action relationships, focusing on unclear logic and uncertainty (Bradan, Kanter, Kopsco, 1989; Jih, 1990). Eliciting these relationships has been known to be a bottleneck for an ES development because domain experts usually have trouble explaining their rationale for solving problems (Johnson, 1983; Weiss & Kulikowski, 1984).
- ES is still a relatively new technology so users do not know what this technique can do for them. Many ES developers have experienced considerable difficulty communicating with users to determine their needs. Therefore, the developers have to determine the condition-action relationships through iterative, knowledge-eliciting processes, by using a working model as a vehicle.

On the basis of these basic differences between ES and TPS/DSS, one might surmise that ES development may require significantly different methodology to guide the development process. Indeed, Hannaford and Harris-Jones (1990) strongly recommend that any ESDLC methodology address several problems which often beset ES development in particular. In practice, individual organizations attempt to address such problems in a variety of ways. Researchers and SDLC methodology vendors try to be of service by proposing their own solutions. Therefore, it should come as no surprise that the literature today has several proposals for an ESDLC (Weitzel & Kerschberg, 1989; Mack, Brule & Levin, 1992; Roberts, 1988; Walters & Nielsen, 1991). However, the presently available ESDLC either have not been validated in practice or have been tested in a limited context (one organization or one project within an organization). Some of the ESDLC proposed in literature represent models which focus only on the knowledge acquisition stage (Buchanan, 1993; Waterman, 1986). The others address a large part of ES development process (Hannaford & Harris-Jones, 1990; Prerau, 1990; Walters & Nielsen, 1988; Weitzel and Kerschberg, 1989), but still leaving out some important activities. What is needed today is some integration of what has already been proposed and a better understanding of what is being widely used in practice. Therefore, in an exploratory fashion, this study has been designed to accomplish four major objectives: (1) to empirically test the usefulness of an ESDLC, (2) to integrate existing ESDLC into one which will be more comprehensive and more widely used in practice, (3) to compare the proposed ESDL to the ones presently used in practice to detect any significant variations, and (4) to discuss the implications of the findings and make recommendations for ES development managers.

**Study Methodology**

The study followed two distinct phases: questionnaire construction, and sampling and data collection. Questionnaire construction encompassed two major activities: integration of existing ESDL methodologies into one likely to be widely accepted in practice, and definition of a list of expected benefits from using an ESDL. The results from both activities were used to develop a short questionnaire containing: (1) company demographics, organization gross revenue, industry, number of operational ES, and number of ES under development; (2) for each activity, the nine activities in our ESDL model plus “other” to be specified by the respondent, in the ES development process, the average percentage of time spent on each; (3) a statement about each of the eight promised benefits, plus “other” to be specified, from ESDL to be agreed or disagreed with on a seven point scale; (4) for each activity in the ESDL proposed here, respondents were asked to indicate if their in-house ESDL had something different (to be specified), similar, or a phase not performed; and (5) for the ES the respondent was familiar with, they were asked to estimate the average proportion of total cost spent on maintenance versus development through their useful lives.

**Developing The Integrated ESDL Model**

Based on the ESDL models proposed in the literature, a preliminary comprehensive model was developed. Based on the iterative process of conceptualization-formulation-implementation-testing (Buchanan, 1993; Waterman, 1986), the study has formulated a cycle of knowledge acquisition, knowledge representation, knowledge implementation, and verification/validation to develop a knowledge base. In this model, we added two phases prior to the iterative process based on Hannaford and Harris-Jones (1990) and Weitzel and Kerschberg (1989): identification and feasibility adopted installation phase and evaluation/maintenance phase from Hannaford and Harris-Jones (1990) and from Prerau (1990). These two phases were inserted after verification/validation phase. The model of ESDL was modified and refined with the input acquired through personal interviews with ES developers and project managers from ten companies, including IBM, Exxon, American Airlines, Dupont, NASA, DEC, Frito...
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