ON DESIGNING EXPERT SUPPORT SYSTEMS USING SYSTEM DYNAMICS AND FUZZY SETS

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CERTIFICATE

The thesis entitled "On Designing Expert Support Systems Using System Dynamics and Fuzzy Sets" being submitted by Mr. Pankaj to the Indian Institute of Technology, Delhi, for the award of the degree of 'Doctor of Philosophy', is a record of bonafide research work carried out by him. He has worked under our guidance and supervision, and has fulfilled the requirements for the submission of this thesis which has attained the standard required for a Ph.D. degree of the Institute. The results presented in this thesis have not been submitted elsewhere for the award of any degree or diploma.

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ABSTRACT

This thesis aims at developing a methodology for designing expert support systems for managerial decision making. A synergistic approach drawing upon some of the techniques of systems modeling and principles of expert systems has been developed. The scope is limited to developing a methodology and supporting tools and its demonstration rather than preparing a real life expert support system.

In the review section, apart from a comprehensive review of the literature related to the study, a state-of-the-art related to the area of research has been established with a view to identify directions for further study and areas of research.

Keeping in view the complexity of the problem and the insights gained from the literature review, a methodological framework for expert support system design has been proposed which utilizes various systems modeling techniques like interpretive structural modeling (ISM), system dynamics (SD), monte-carlo simulation, and also fuzzy set theoretic concepts to handle uncertainties and vagueness in the systems.

The operationalization of the methodological framework begins with the development of an interpretive structural model from a mental model. This ISM is converted into a causal loop structure which is then translated into a knowledge-base. This knowledge base allows one to perform qualitative structural analysis of the model.

The knowledge base is expanded further so as to generate a system dynamics simulation model from it. An expert system is developed which automatically generates

DYNAMO equations directly from the causal loop structure thereby bypassing the flow diagramming stage. A number of policy experiments are carried out in the model and results discussed.

An attempt has been made to incorporate stochasticity due to fluctuations in parameters and variables into SD models using monte-carlo simulation technique.

The other kind of uncertainties and vagueness owing to beliefs and perceptions of the managers have been dealt with the help of fuzzy set theoretic concepts. A fuzzy set theoretic approach for qualitative analysis of causal loops has been developed which makes use of concepts like linguistic variables modus ponens rule, fuzzy relation, composition, possibility distribution, etc.

The same model based on fuzzy relational approach has been extended to apply the fuzzy relation equation for backward analysis of a causal loop structure which helps in determining the values of various parameters and variables to reach a desired state of existence.

The various phases developed have been illustrated with the help of a market growth production model.

Finally, it has been endeavored to synthesize the research efforts made in the previous chapters, towards a comprehensive expert support system design. The final form of the design and the various implementation aspects such as the manner of knowledge acquisition, knowledge updating, etc. have been discussed.

The research study concludes with the discussion on significant contribution of the research, limitations of the research and futuristic considerations.

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