

Modelling Of Agro-Based Industrial Expert System

Abdur Rashid Khan

ICIT, Gomal University,
Dera Ismail Khan, Pakistan
rashidkh08@yahoo.com dr.arashid@gu.edu.pk

Abstract—Models are the best information carriers in terms of symbols or numbers rather than with actual tangible objects in an *abstract* way to depict the imaginations and thoughts of decision makers about their areas of domain. Modelling plays a vital role in both the system's understanding as well as in physical design and implementation of any problem domain. In this work various models have been developed to depict the Agro-Based Industrial Expert System (AIES). These models will be helpful for students, researchers and developers with having an example of practical application in their fields of interests. This work is not only related and useful for computer personnel but will also be helpful to various other fields of studies, like; Agriculture, Management, Business etc. Modelling approaches, like; Entity Relationship, Functional, Business Process, Workflow, Symbolic, Tree Diagrams, Dependency Diagrams, and Knowledge Representation (Ruled-based and Certainty Factors) have been discussed in this paper. These models can further be expanded to different areas of research and developments.

Keywords—Expert Systems; Agro-Based Industries; Symbolic Models; Diagrammatic Models; Functional Models; Business Process Models; Knowledge Representation

I. INTRODUCTION

This work is a part of my thesis research work. Modelling generally refers to the idea of abstract representation of the problem at hand. It is a device used to view the reality in a well-structured way. The three main types of models are: Iconic (Physical), Analogue (Schematic) and Mathematical/Symbolic. The benefit of using an information model is that it can provide a sharable, stable, and organized structure of information requirements for the domain context. Due to the suitability and nature of the problem domain, ruled-based system was adopted as a knowledge representation technique [1].

The models being described in the paper are; ER (Entity Relationship), Functional, Business Process (IDEF0), Workflow (IDEF3) Approaches, Symbolic Modeling, Tree Diagrams, Dependency Diagrams (DD), Knowledge Representation (Ruled-based and

Certainty Factors). These models have been described in detail in Discussion and Results sections.

II. STUDY BACKGROUND

A **model** is a representation of structure in a physical system and/or its properties. It describes (or specifies) four types of structures, each with internal and external components [2]:

- **Systemic structure** specifies; composition (internal parts of the system), environment (external agents linked to the system) and connections (external and internal causal links).
- **Geometric structure** specifies; position with respect to a reference frame (external geometry) and configuration (geometric relations among the parts).
- **Temporal structure** specifies change in state variables (system properties); descriptive models represent change by explicit functions of time and causal models specify change by differential equations with interaction laws.
- **Interaction structure** specifies interaction laws expressing interactions among causal links, usually as function of state variables.

Models and model development are useful for helping students learn quantitative skills such as graphing, graphical analysis, and visualization; statistics; computational skills, mathematics. Fig 1 shows a complete model comprising five sub-models to depict the real-world problems [2].

The main goal of this research work is Expert system named as ESPMS (Expert System for Process Model Selection) has been developed to guide the Software Engineer for decision making about selection and evaluation of software process model [3].

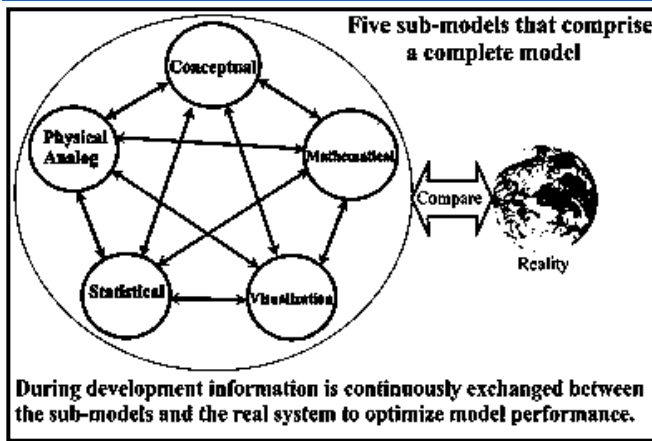


Fig 1: Five Sub-Models of a Complete Model

Literature study reveals that numerous modelling techniques exist in books, research papers and internet and have categorized according to the usage or nature of the problem domain. All models being used and discussed here are based upon my PhD thesis research work and play a vital role to understand and solve the real-world problem of application of Expert System's Technology in Agro-based industrial sector. In this work of research all these models have been consolidated within a single problem domain to facilitate the audiences. Results and further details of this work can be seen in [4].

III. RESEARCH & DISCUSSIONS

Following sections describe the actual implementations of these models in the problem domain.

3.1 Entity Relationship (ERwin) Modeling Approach

The three schemas include an external schema (the user view of the information), an internal schema (the computer view of the information), and a conceptual schema (a logical, neutral view of the information). It provides a consistent definition of the meanings and interrelationship of the data in order to share, integrate, and manage the data [1].

As stated earlier ERwin support two types of modeling: logical (requirement) and physical (decision). In an entity-relationship diagram, a relationship shows an association between two entities being represented by a line connecting two entities. See Fig 2 as shown below.

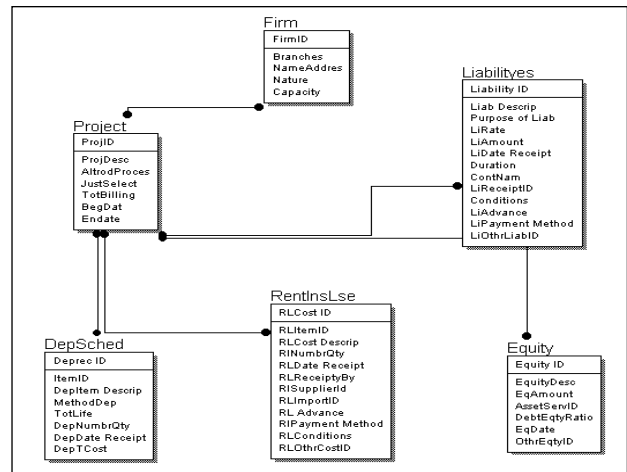


Fig 2: Logical Model of the AIES showing Plan Financing Detail

Similarly, the physical model has been shown in the Fig 3 as given below.

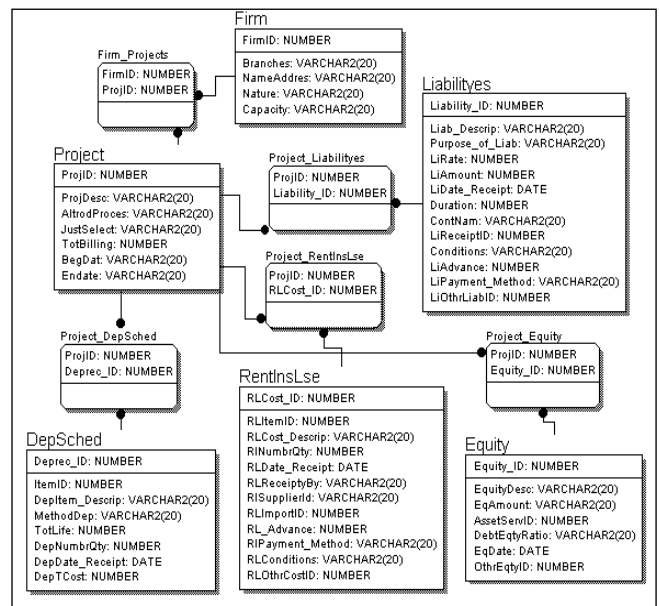


Fig 3: Physical Model of the AIES showing Plan Financing Detail

Models of the problem domain are schematic in nature and may be viewed in different levels, e.g., Entity, Attribute, Primary Key, Definition, and Icon. These models were divided into: Main Subject Area, Project-Company, Plan Financing, Plant Detail, Cost-Benefits, Marketing, and Incentives (for investors). Main subject area (by default) includes all the objects (entities, tables, views and text blocks in a data model).

3.2 Functional Modelling (BPwin) Approach

BPwin is a powerful business process-modeling tool that might help to analyze, document, and improve complex business processes. BPwin supports three types of Process Modeling Methodologies: Business Process (IDEF0), Workflow (IDEF3), and Dataflow (DFD). The reader may easily capture information at a glance on process flow and workflow that what

resources and information are needed to complete these activities as well as relationships among them respectively.

3.2.1 Business Process Modelling (IDEF0) Approach

Business Process Modelling (IDEF0) activity modelling, analyzes the whole system as a set of interrelated activities or functions. These activities that represent verbs phrase, of the system are analyzed independently of the objects(s) or noun(s) that perform them. For example, we have modeled the Decision-Making process as we envision it to be in the future rather than how it currently operates, i.e., TO-BE time frame. The evaluation process of expert system model of the AIES was shown in the context (Fig 4) as well as in the detail view.

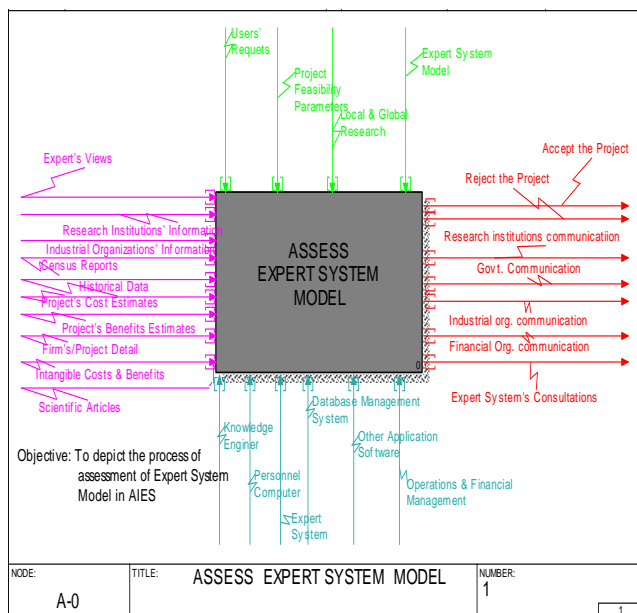


Fig 4: Context View of Process Flow Model of the AIES

The context view (top-down approach) in Fig 4 depicts the activity “ASSESS EXPERT SYSTEM MODEL”, with its child view as, i.e., EVALUATE ECONOMIC FEASIBILITY, EVALUATE TECHNICAL FEASIBILITY, and ASSESS GENERAL FEASIBILITY.

This diagram shows all Inputs, Controls, Outputs, and Mechanisms of the ES through using arrows to complete these activities. The association property may be seen in the diagram through all those entities that follows them, which are dependent upon the previous entities.

3.2.2 Workflow (IDEF3) Modelling Approach

This primary objective of the workflow diagramming is to provide a structural method that describes a situation as an ordered sequence of events, as well as describes any participating objects and the rules associated. In Fig 5 various interrelated activities have been logically connected to arrive at a decision point.

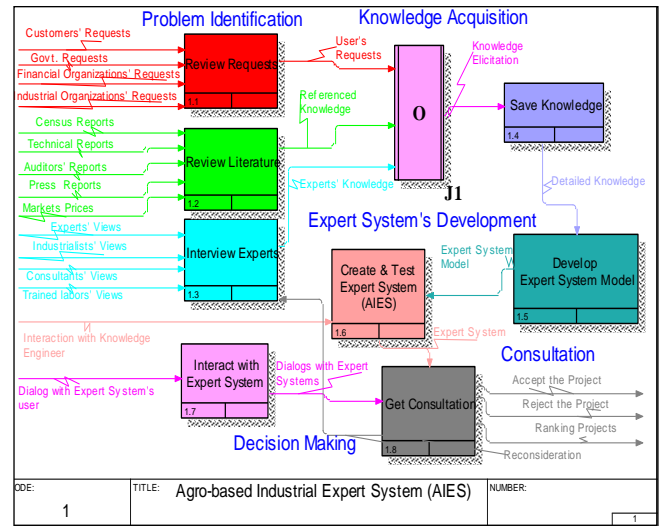


Fig 5: Context View of Work Flow Model of the AIES

In the workflow modeling, the entities named as: Review Requests, Review Literature, and Interview Experts, were classified (grouped) into **Problem Identification**, depicting the “inheritance-from” and “inheritance-to” among entities. Then these entities were combined together using “AND” junction. The retrieved knowledge was shown through “Save knowledge” activity grouping the process as **Knowledge Acquisition**. The entities “Develop Expert System Model”, and “Create & Test Expert System” were classified into **Expert System's Development**. Dialog with Expert System, and “Give Suggestion” entities were called as **Decision Making**. Finally the **Consultation** shows whether to: *Accept the Project*, *Reject the Project*, *Ranking Projects* and *Reconsideration*. These diagrams shows what processes are involved in the ES and how they relate among each other.

3.3 Symbolic Modelling

A Symbolic or Mathematical model is the description of an activity, which expresses the relationship amongst the various elements with sufficient accuracy that can be used to predict the actual outcome under any expected set of circumstances. Some of the computational formulae have been shown symbolically as below:

Net Present Value (NPV):

NPV may be defined as, the present value of the cash inflows minus the present value of the cash outflows. NPV calculates the net present value of an investment by using a discount rate and a series of future payments (negative values) and income (positive values).

Discount rate (r) can be found out from the relationship, [1],

$$FVt = PV * (1+r)^t \quad (1)$$

Where PV represents the present value of the investment, FV is the future value of the investment after the time period t.

Similarly Dominick Salvatore defined: [1]

$$PV = \pi_1 / (1+r)^1 + \pi_2 / (1+r)^2 + \pi_3 / (1+r)^3 + \dots + \pi_n / (1+r)^n$$

$$(1+r)^n = \sum_{t=1}^n \frac{\pi_t}{(1+r)^t} \quad (2)$$

Where, PV represents all expected future profits, $\pi_1, \pi_2, \dots, \pi_n$ represent the expected profits in each of the n years considered.

$$NPV = \sum_{t=1}^n \frac{R_t}{(1+k)^t} - C_0 \quad (3)$$

Where, NPV represents net present value, R_t refers to the net cash flow or return from the investment project in each of the n time periods considered, k is the risk-adjusted discount rate, Σ refers to the sum of the present discounted value of all the future net cash flows from the investment, and C_0 is the initial cost of the investment.

Internal Rate of Return (IRR):

The internal rate of return on a project is the discount rate that equates the present value of the net cash flow from the project to the initial cost of the project [1].

The IRR may be obtained by solving the following equation, for k^* .

$$C_0 = \sum_{t=1}^n \frac{R_t}{(1+k^*)^t} \quad (4)$$

While the $IRR=k^*$ on a project can be obtained by trial and error method.

Sales Forecast (Least Squares Method)

This method is used for finding the production or sales for a particular year, which is given as below [1]:

$$a = \sum y / N \quad (5)$$

$$b = \frac{\sum xy}{\sum x^2} \quad (6)$$

$$x = \text{required year} - \text{midyear} \quad (7)$$

$$y_c = a + b \cdot x \quad (8)$$

While, a is the value of y variable when $x = 0$, Y represents actual sales or production, y_c represents computed value of y, b represents the slope of the line or amount of change in y, which is associated with a change of one unit in x, x represents the time (year).

The Capital Asset Pricing Model (CAPM)

CAPM may be computed as [1]:

$$K_P = K_{RF} + (K_M - K_{RF}) \times \beta \quad (9)$$

Where, K_P = the required rate of return appropriate for the investment project, K_{RF} = the risk free rate of return, K_M = the required rate of return on the overall market, and β = the project's beta.

3.4 Tree Diagrams

The whole structure of the ES model was represented as tree structures. All decision-making parameters were represented in tree diagrams that depict the relationship among these parameters. The top element is divided into its sub-elements as shown in Fig 6. Project feasibility was divided into its sub elements as economic, technical, and general feasibilities. See all these related figures in the LIST OF FIGURES in [1] and [4].

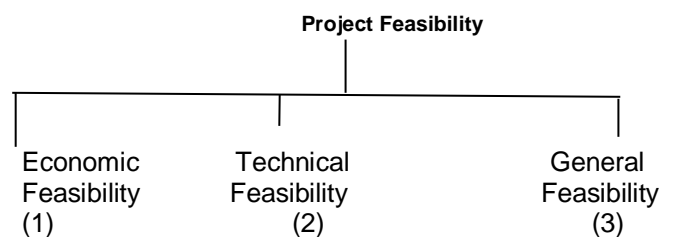


Fig 6: Main Tree-diagram of the Expert System's Model

While the Economic Feasibility consists of the factors shown in Fig 7. Again these factors have been further divided into numerous other factors as being described in [1] and [4]. Similarly the Technical Feasibility as well as the General Feasibility details can be seen there.

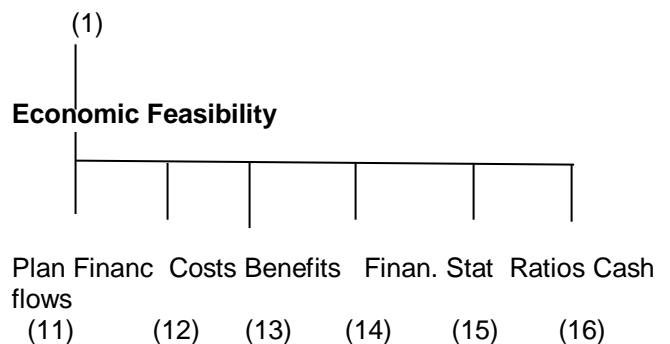


Fig 7: Tree-diagram for Economic Feasibility

3.5 Dependency Diagrams (DD)

Dependency diagrams adopted in An Expert System for Feasibility Assessment of Product Development, represent the overall structure of the Knowledge Base [5].

The DD show the structure of the knowledge base (KB) adopted in AIES, which can be seen in Fig 8.

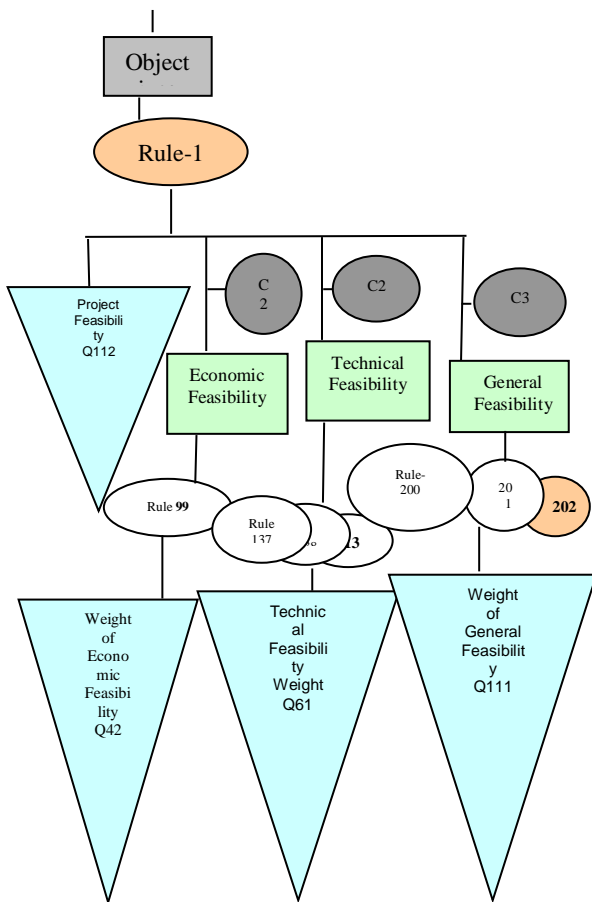


Fig 8: Main Dependency Diagram of the ES Model

3.6 Knowledge Representation

Knowledge Representation (KR) is based upon the knowledge of the problem domain for which the Expert System is being developed. Production rules of KR and Fuzzy Logic was adopted to develop the Expert System. A short description is given here in **Table 1** as below [4]:

Table 1: Section of Economic Feasibility Assessment

```

section economi_feas: 'Economic Feasibility Assessment'
/* Economic Feasibility Computation:*/
do clrparam do resdde do fincplan
do costs do benefits do finstat
do ratios do ratiosb do npv
do irr do arr do pvi_sec
do pback do pbdcf
do saveco
parameter cfeco : 'CF of Economic Feasibility '
type number
explanation ''
/* rules field */
rules
cfecopar,true,
0.0.
/* range field */
range 0.0 0.5
    
```

Similarly, using Certainty Factor technique for evaluation of the Expert System's Model can be seen in the **Table 2** as given below [1]:

Table 2: Addition of Certainty Factors of two parameters

$$\begin{aligned}
 &\text{Rule A:} \\
 &\text{IF X AND Y} \\
 &\text{THEN Z(CF = .75).} \\
 &\text{Rule B:} \\
 &\text{IF D AND E} \\
 &\text{THEN F(CF = .3).} \\
 &\text{CF(C) = CF(A) + CF(B) - CF(A)*CF(B)} \\
 &= .75 + .3 - (.75)(.3) \\
 &= 1.05 - .225 \\
 &= .825
 \end{aligned}$$

IV. CONCLUSION AND FURTHER WORK

From this research work we can conclude that when a problem is shown in the form of various models then it becomes crystal clear to both the developers as well as the users. Each and every problem is set of components which require to be modelled in a proper way to understand and solve the problem at hand. All these models can be used by divert type of users in numerous fields of sciences, especially in Computer Science, Management and Business, Engineering, Agriculture etc.

REFERENCES

[1] Abdur Rashid Khan, Expert System for Investments' Analyses in Agro-based Industrial Sector of the Economy. AV Akademikerverlag GmbH & Co. KG, Heinrich-Böcking-Str. 6-8, 66121, Saarbrücken, Germany, www.lap-publishing.com ISBN: 978-3-8473-2341-9, 2012

[2]. David Hestenes, Modeling Methodology for Physics Teachers, Proceedings of the International Conference on Undergraduate Physics Education (College Park, August 1996).

[3] Abdur Rashid Khan, Zia Ur Rehman and Hafeez Ullah Amin, Knowledge-Based System's Modeling for Software Process Model Selection. International Journal of Advanced Computer Science and Applications (IJACSA), Vol. 2, No.2, February 2011, <http://ijacsa.thesai.org/>

[4] Abdur Rashid Khan. Economic Feasibility of Investment in Agro-Based Industries- Using AIES, International Journal of Agriculture & Biology 1560-8530/2004/06-4-676-682 <http://www.ijab.org>

[5] Jacky Akoka and Bernard Leune, Alexis Koster, Expert Systems with Applications, Elsevier Science Ltd, Volume 7, No. 2, pp. 291-303, 1994.