CHAPTER 3

A Multi Layer Knowledge Based Adviser for Small-Scale and Cottage Industries

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3.1 INTRODUCTION

This chapter addresses the development of a design of knowledge base called multi layer knowledge base. The case discussed here is an effort to bridge the technological gap between rural and urban environment and providing marketing and financial assistance for the small-scale and cottage industry proprietors for rural development. The features and difficulties of the business and people involved in it are described in the case besides the proposed Knowledge Based System.

3.1.1 Indian Economy:

Approximately 74% of the total population in India is living in rural area[1]. Upgradation of such rural area will surely uplift the whole country. In fact, there are considerable areas in the country which have remain backward that can be treated both as a CHALLENGE and an OPPORTUNITY for the development. Generally, economic development is given the highest priority among development of social environment, social infrastructure and human capital[2]. However, we need to emphasis more on INFOSTRUCTURE—structure of information. According to World Bank's World Development Report Classification in the year 1998, India is considered as a country having developing economy with the Gross National Product(GNP) as only 421.3 billion dollars with the population contribution over 34% of total world's population, whereas high economy countries are having 22,599 billion dollars GNP approximately[1]. One way to improve GNP is by creating and/or increasing employment which affect mass using technological aids. Creation of employment in the rural sectors needs information/advise about rural industries. KBS can provide knowledge, skills and motivate users for given business. As a large percentage of the total population in India live below the line of poverty, upgradation of rural industries can directly effect the above class.

3.1.2 Role of Small and Cottage Industries in Indian Economy:

People are impressed by large-scale industries and it has become customary to emphasis the growth of large-scale industries as basic to industrial growth. But the contribution of the small-scale industries in terms of production and employment is SUBSTANTIAL. The small-scale industries are given a special role for creating an additional employment with low capital investment. Such small units, therefore, form an integral part of the Indian economy and constitute an important element in the plan of industrialization of the country. The small scale industries sector with
high potential for gainful employement opportunities, contributes nearly 40% of the total industrial output. At 30.14 lakh units, the number of units under small scale industries have increased by 5.5% in 1397-98. However due to globalization, the growth of production in small scale industries at constant prices has decelerated from 11.3% in 1996-97 to 8.4% in 1997-98[13]. These industries may be directly servicing to the urban/town areas and urban industries can be linked with the metropolitan industries. The urban proprietors are using the resources like labour, land and other raw material from village area and serve the finished and semi finished product to metropolitan industries. This type of link is desired to exist for mutual benefits of the village and other industries. Also, growing rural areas provide new important markets for urban service and manufactured goods. Nearby cities provide ready markets for agricultural products such as vegetables, dairy products and for rural nonfarm output. Rural industries often supply parts and components to nearby urban manufacturers. Developed areas help to raise rural productivity through technology transfer, educational services and training[1].

Small-scale industries are often known as village industries, tiny industries or cottage industries. Traditional village or cottage industries are generally located in small or undeveloped villages. These kind of small industries are labour intensive and they provide seasonal/nonseasonal employment to the poor people. Such cottage industries mostly use traditional techniques for production like khadi & handloom, handicraft, coir, sericulture, fisheries, oil-seeds crushing, lather tanning etc. Modern small scale industries are located in big villages or towns. They can use modern technology to produce sophisticated products viz. semi-paddy product, semi-milk product and other products as an ancillary base to the big enterprises.

3.1.3 Features of the Business:

Some of the features of the small-scale industries which can be helpful to economically uplift rural industries are listed below:

(a) Light skill and less capital
(b) Comparatively quick investments and fast yield
(c) Labour intensive
(d) Personal supervision/management possible
(e) Sole proprietorship mostly or very few partners
(f) An ancillary base for large industries

However, there are some problems experienced with the business like backward techniques of production, lack of finance & high interest offered from private money lenders and poor marketing strategies & transportation facilities etc. Following suggestions can be used as a remedy to the problems:

(a) Use of the Government help and to make the people concerned with the business aware of various schemes introduced for their welfare, using advertising media like TV, Radio and Newspapers
(b) To provide training for technical, financial and marketing assistance.
(c) To form and to promote small-scale and cottage industries federation. These kind of service institutions may arrange workshops, business fairs, and seminars or provides training to the staff.

etc.
As stated earlier, KBS can help in educating and motivating users for the business by enhancing their skills and providing knowledge of the business. Human and/or machine-based experts/advisers can be placed at different locations. Since human experts and their knowledge are limited commodities in the field, one alternative is to use Knowledge Based Systems (KBS) for the same purpose.

3.2 PROPOSED SYSTEM

3.2.1 Objectives:

It is observed that representation and autonomous manipulation of knowledge is real power. We may conclude that knowledge is the power and economic knowledge is the economic power. As stated earlier, to create additional employment in rural industries and to promote the industries, knowledge about the business is necessary. Also, the knowledge should be available to common person on demand. This leads to decentralization of planning and information availability because same type of strategies may not be applicable to every rural unit. Also, Information Technology now being considered as core part of a business, therefore computing personnel will be required to meet enterprises objectives, budget and plans. On the base of these objectives an electronic adviser for small and cottage industries through Multi Layer Knowledge Based application is proposed, which provides technical assistance and advisories in activities like following:

- Product selection
- Material acquisition and/or Resource Management
- Finance
- Production process
- Warehouse management
- Transportation
- Distribution and Marketing
- etc.

Also, to achieve qualitative features like reliability, safety, maintainability, producibility etc. the KBS can monitor and enhance the product aspects like:

- Whether the product fulfils the customer needs and predefined standards and/or design specifications if any.
For DECISION PROCESSING, clustering based on different types of industries against some attributes like labour, cost, season etc. are suggested. Layers in the Multi Layer Knowledge Based System can be structured depending on the clustering.

In JAPANESE WAY OF REENGINEERING, real-time information sharing through the application of Information Technology, systems able to provide products and services that are instantly responsive to customer needs is very important factor which redesign business process with customer value and satisfaction as priorities[14]. The proposed Knowledge Based system is a step ahead in this direction.

3.2.2 Multi Layer Structure of the KBS:

For an intelligent system, in order to perform task such as decision making, explanation and reasoning etc., its database must be provided with vast amount of information. The construction and maintenance of a huge hierarchically structured knowledge base is then a non-trivial task[6]. Thus, we suggest knowledge base leveling beside knowledge structuring and knowledge classification. The layers may have single structured with one strict hierarchy or integrated heterogeneous structured hierarchy linked with each other.

When necessary, few of the layers can work independently as a database without invoking or disturbing others. Each layer again may be subdivided into sub layers having same or different architecture. One of them must be the control layer, which includes the domain knowledge and integration strategies for control layer and other layers beside some general problem solving strategies. The number of layers in the knowledge base depends
mainly on the complexity of the domain, technology available and nature of the application. The knowledge base with only two layers, one of them as the control layer, may be identified as bi-layer knowledge base. Figure 3.2 describes the proposed structure of the KBS and Figure 3.3 describes the layers graphically.

3.2.3 Advantages of the Multi Layer Architecture:

Multi layer structure of knowledge base has some advantages in terms of its speed and ease of inferring, over single layer knowledge base, particularly when complex heterogeneous knowledge with different hierarchical structured is stored in a single layer knowledge base. While dividing the information into different layers one can simplify the situation as each layer may contain homogeneous knowledge besides some control language (see Figure 3.2), which makes searching and inferring efficient and may improve quality.

As homogeneous knowledge is stored in each layer, every layer can work independently with the collaboration of the CONTROL or BASE layer. Thus, the modularity of the system is increased; and because of low coupling, the system can be easily maintained and becomes portable.

For the complex application, by dividing the knowledge into different layers complexity can be reduced. In the same way, knowledge for large application can be divided into layers and as a result inferring may become powerful. Also, hierarchical structuring may fit into many problem solving situation[9]. In addition, the number of layers in a knowledge base is kept flexible, thus, if knowledge about a particular area is not sufficient, one can always logically combine two/more layers of the system. One can add or remove one/more layers according to the availability of memory and hardware capacity.
Figure 3.2: Multi Layer Structure of Knowledge Base
Figure 3.3: Structure of Sub Layers
3.2.4 Control Layer in the System:

Whenever decision making is not needed, the layer can fulfill the need of information independently, just as databases do. But still, the internal process requires decision to select appropriate layer. For this, information about the layers in the knowledge base is kept into the CONTROL or BASE Layer. The request of the user is filtered out by the control layer to determine which layer or combination of layers should be selected. For a request, if result is directly available in any of the layer, it can be directly provided to the user otherwise it is followed by further inferencing using the heuristics and knowledge stored in the base layer. The some of the major functions of a control layer are to determine the layer(s) to be inferred, problem solving strategy to be followed and presentation of solution. For that, the control layer contains general problem solving strategies, applications and integrating heuristics, information about layers and control knowledge specific to the domain. Selection of knowledge in control layer generally depends on its size, characteristics and nature of the knowledge in different layers. The knowledge produced while machine learning may involve new knowledge produced during inferences, which may contains the information about more than one layers. Such hybrid knowledge can be placed in the control layer or in the control sub-layer of any particular layer.

In addition, instead of having only a single layer as control or base layer, one can have two or more control layers in the knowledge base depending on the application of the interest, complexity of the knowledge and number of layers into the system. Also, as stated earlier, one can have an independent information source outside of the knowledge base viz. statistical and mathematical models and general problem strategies with additional data models. This additional source of data is an optional entity, and its presence may require changes in integrating heuristics and inference methods.

3.2.5 Control Strategy:

When knowledge base is modeled by the parallel representation of an arbitrary number of separate layers, it is obvious that knowledge base contains different types of heuristics having one or more storage architecture. Consider N different layers in such multi layer knowledge base, say $S_1, S_2, ..., S_N$. Each layer contain a set of heuristics say $H_1, H_2, ..., H_N$ corresponding to each layer with respective discernment $\theta_1, \theta_2, ..., \theta_N$. In this case, the $i^{th}$ layer is considered as an order pair $(H_i, \theta_i)$. Thus, the set of subset of the set $\theta_i$ is $Z^{\theta_i}$. It is the control layer, which
determines heuristic to be selected under given circumstances. A 
MEMBERSHIP FUNCTION can be defined as follows to determine the 
appropriate control heuristic among all available heuristics.

\[ C: \mathcal{Z}^\theta \rightarrow [0, 1], \]

where \( c(\phi) = 0 \) & \( \Sigma c(a) = 1 \) for all \( a \in \theta \),

and \( \theta \) is the set of subsets of all available heuristics. ... Eq. (1)

The selection strategy of the control heuristic may contain one or more such
functions to select proper heuristic at particular level. In other word,
depending on attribute value, one function or problem solving strategy has
To be selected which needs again one control heuristic such as
MEMBERSHIP FUNCTION. Using Rule Value Approach, this membership
function can be easily implemented. One such function for Shoe Making
and Lather Industries is given in Figure 3.5.

3.3 AN APPLICATION

The three layer structure is introduced for the KBS as an adviser for small-
scale and cottage industries. The bottom layer, layer 1 is the control layer
which consists of rules, heuristics, general problem solving strategies and
integrating heuristics for efficient integration of the layers. The layers 2
and 3 are application layers with some control knowledge, which may help
in linking the layers. The second layer contains business information like
code of the business, climatic condition of the business, manpower
requirements, capital & finance need for the business, Government
approach and estimated profit within fixed amount of time & capital etc. The
third layer contains village information like village code & its preliminary
information, product-wise climatic conditions, raw material availability,
natural resources, federation etc. The structure of the knowledge base
can be as shown in Figure 3.4.
3.3.1 Membership Functions for Shoe Making Business:

Shoe making business in a block of Gujarat state (Vallabhi Vidyaganagar) is taken under consideration for a survey. Proprietors doing the business are interviewed and collection of data is made. The result is presented in the Figure 3.5. To determine goodness (degree of acceptance) of the business two membership functions are defined for local as well as for foreign market. These functions are following pattern of continuous membership function (see Eq. 1). However, one can design the same for discrete function also.
FOR LOCAL MARKET

1.0185 - 0.0939*X - 0.0702*X*X for X=May to Aug
1.86E - 0.0139*X * X for X=Sep to Nov
1/(0.6531*(X - 5.9208)^2 + 1.1415) for X=Dec to Jan
1/(0.7619 *(X - 9.8250)^2 + 1.3671) for X=Feb to Mar
0.0286 * (X/3.5149)^0.2558*E(X/3.5149) for X=Apr

FOR FOREIGN MARKET

2.2533 - 0.1812*X for X=Dec to Apr
1.8765 - 0.4321*X + 0.0407*X*X for X=Sep to Nov
10.2327 + 0.0552 *X + 0.0349*X*X for X=May to Aug

Figure 3.5: Membership Functions for Shoe Making Business
3.3.2 Some Rules for illustration:

As an illustration some sample rules are given for the advisory system for small and cottage industries using Hierarchical Censored Production Rules[15] methodology as follows:

(R1) GENERAL-BUSINESS-INFO

If user-interest-isin-less-capital

and village-environment is Normal with value >0.60

Unless

Generality Show General-Information

Specifically

(R2) TYPED-BUSINESS-INFORMATION

If user-interest-isin-domestic

Unless village-Soil is Silica with value >0.45

Generality Show Potries-Information

Specifically Show Clay-Work-Information

(R3) TYPED-BUSINESS-INFORMATION

If user-interest-isin-domestic and

village-isin-sea-border-south

Unless

Generality Show Coir-Information

Specifically Show Coconut-Information

(R4) FINANCIAL-INFORMATION

If user-interest isin-petrochem and

annual-income-of-user is less with value >0.59

Unless

Generally show petro-chem-financial-information

Specifically
(R5) MARKETING-INFORMATION
If user-interest-isin-domestic-handicraft
Unless[ ]
Generally show nearby-market-information
Specifically show export-market-information

(R6) SEASONAL-INFORMATION
If user-interest-isin-fruits-n-vegs and
current-season-is-winter
Unless[ ]
Generally advise to stock potatoes
Specifically list nearby-potato-selling-market

(R7) CONTROL-INFORMATION
If user-village-isin-sea-border-category
Unless user-interest-isin-domestic
Generally show fisheries-information
Specifically select sea-border-villages from village-layer

3.4 VALIDATION & VERIFICATION REPOSITORY

3.4.1 Importance and need of V & V techniques:
The need for effective verification, validation and integrity (VVI) is well established in DataBase and Expert System(ES) communities. The proposed multi layer KBS can be considered as a member of the same category. VVI requirements will continue to grow in such fields because of:

- The exponential growth in potential user populations,
- The potential for distributed multi-component systems, such as multi-agent-systems, and
- The expanding range of application to which ES and DB technology can be applied.

The primary goal of Verification & Validation (V & V) activities is to assess and improve the quality of the intermediate work products and deliverable
items in a software projects. There are at least two reasons to remain optimistic about future prospects of formal V & V technology. The one is the use of formal verification techniques to guide systematic synthesis of algorithms and the other is the advent of automated verification tools.

Popular automated V & V techniques may be

- Automated Cross Reference
- Mathematical Proofs
- Prototypes/Virtual Prototypes
- Simple Automated Models
- etc.

The automated V & V techniques may be useful in solving the fundamental problems of software development like complexity control, lack of boundaries and constraints (physical) etc. It provides the way by which we can examine a stable set of decisions which are free from other constraints. It has been proven that the size of project doesn't have any effect on Automated Cross Referencing.

3.4.2 V & V Layer:

Taking into consideration the above requirements of V & V techniques, it is desired that any system should pass through this phase. For Knowledge Based System, in addition to a self learning module, a V & V layer can be added optionally. Here an architecture of a Knowledge Based System integrated with a database/repository of V & V techniques (See Figure 3.6) is proposed as one of the layers in multi layer environment. The repository is a set of mechanisms of V & V techniques for knowledge to knowledge and knowledge to tool integration.
3.4.3 How it Works?:

As described earlier, the multi layer knowledge base, as the name suggests, contains more than one layers in the knowledge base. The base layer which takes care of layer selecting, accessing and updating of the contents(self learning process) is called the control layer. Generally, there is one control layer in such configuration. Number of control layers can be enhanced according to the need and complexity of knowledge and its representation. Whenever the knowledge base is free i.e. not accessing the information/knowledge from the given layers, the self learning goes on. At the same time when updation of the existing knowledge is going on, control layer checks the newly produced knowledge against V & V besides the knowledge available in the knowledge base. The following benefits may be achieved:

- Newly learned knowledge is tested.
- V & V repository is also tested with respect to the existing knowledge.
Putting a separate layer beside control layer and information layers in multi layer knowledge base for V & V purpose may save good amount of cost, but might increase in complexity of the system, memory requirement and time of inferencing. On other hand, the KBS and V & V Repository both remain up to date. Moreover, the V & V techniques are documented in a proper way and may work as a centralized repository, which can be (re)used for many different applications. Hence, such concept offers modularity, reusability, ease of use, quick updation of the repository (V & V) contents, easy documentation of V & V and portability in some cases. The overall system may become more simple and user friendly by hiding the information. The reusability of the repository may help in applying the traditional automated V & V techniques to any application, which has to be go through the V & V Process.

3.5 CONCLUSION

The development of small-scale industries is very slow because of the present low level of technology, shortage of trained and experienced supervisory/advisory personnel etc. Provision of technical service is therefore, an important and justified form of aid to increase productive efficiency and encourage new product lines. As the Government has employed computerization for the information available in the rural area, these databases can be combined with the proposed system as one of the layers. In addition, it is not necessary to have all the layers in the system into the main memory. Hence a Multi Layer Knowledge Based System with control strategy is proposed to increase modularity and portability. An additional V & V layer serves as a knowledge checker as well as provides documentation of V & V techniques.

3.6 FURTHER RESEARCH SCOPE

The integrated heuristic and self learning from knowledge base form an additional layer of the KBS proposed may be the next step of the development process. Selection of appropriate search strategies and structuring of the knowledge base in layer may be the related future work. Such advisory system can be a module for a full product manufacturing cum advisory system. An integrated electronic version of which can be used to conduct and supervise every phase of business globally on Internet.
3.7 REFERENCES


6. Dan I Moldovan, wing Lee and Changhwa Lin, "Parallel Knowledge Processing on SNAP", IEEE Transactions on Knowledge and Data Engineering,1993, pp.65


