ISAHP 1996, Vancouver, Canada, July 12-15, 1996

THE SELECTION OF FORECASTING METHODS AND SOFTWARE WITH THE AHP

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Abstract: The study describes the selection of forecasting methods and software with special reference to Expert Choice for Windows, Version 9.0.

1 AHP Approach

1.1 Guidelines

The general approach to using the AHP methodology consists of five phases which can be briefly characterized as follows:
- *Development of the hierarchical structure* for the decision problem.
- *Determination of local priorities* among the decision criteria in the hierarchy.
- *Determination of global priorities* with respect to the top element of the entire hierarchy (goal).
- *Consistency checking* and/or *sensitivity analysis* of the judgements.
- *Final ranking of the alternatives* under investigation and *decision making* based on the results of the evaluation process.

Some preliminary steps involve the
- *selection of AHP experts*

and the
- *formation of project teams* assuring management cooperation and support.

The aforementioned guidelines can be refined in various ways. In many cases it will be absolutely necessary to organize
- *special seminars*

to acquaint the participating practitioners with the AHP methodology in general and relevant details concerning the determination of the L (local) and G (global) priorities.

1.2 Practice

With respect to the evaluation of forecasting methods and software
- *compact refresher courses*

can offer a comprehensive view of AHP with special reference to the relevant measurement techniques (relative/absolute measurement).
As to the
- *AHP software*

a decision in favour of versatile and user friendly packages has to be made.
In the current case study
- *Expert Choice for Windows , Version 9.0*

has been used.

2 Evaluation of Forecasting Methods

The proposed evaluation program is characterized by the inclusion of a
- *large number of alternatives.*
The evaluation process consists of several phases which encompass the
- *selection and hierarchization of the evaluation criteria*
followed by the
- *determination of local and global attribute weights*
and the
- *evaluation/ranking of pre-selected forecasting methods.*
When the
- *absolute measurement technique*
is used the alternatives are compared against previously established scales rather than relative to one another as in the case of
- *relative measurement.*

2.1 Modelling

AHP based evaluation processes refer in most cases to hierarchically structured models that include a
- *large number of evaluation criteria.*
This holds also true for models concerning the evaluation of forecasting methods.

2.1.1 Criteria Selection

Case studies concerning forecasting methods show that the evaluation criteria can be assigned to three groups as indicated in Table 1.

Table 1. Evaluation criteria: Forecasting methods

Evaluation of forecasting methods
1 Structural factors
- Forecasting
- Forecasting horizon (short/medium/long)
- Forecasting periods (short/long)
- Data structure
- Data pattern (stationary/seasonal/trend/cycle)
- Data requirements (number of periods)
2 Technical factors
- Data preparation
- Flexibility
- Accuracy (general pattern/turning points)
3 Supplementary factors
- Comprehensibility/acceptability of the method
- Applicability/relevance of the results
- Costs (introduction/operation)

2.1.1.1 Structural Factors

Structural criteria lead to a classification of forecasting methods according to the
- *forecasting horzions and periods*
as well as to the
- *data structures* involved in the analysis.
It is generally useful to consider three forecasting horizons (short/medium/long-term) and to differentiate between short/long forecasting periods. Additional criteria refer to the basic data patterns and the minimum data requirements.

2.1.1.2 Technical Factors

Technical criteria help to classify the forecasting methods with respect to the
- *need and type of data prepartions*
as well as to the
- *general flexibility of a method*
which depends mainly on the possibility to analyse a variety of data patterns.
Of central importance are the criteria relating to the
- *accuracy of the forecasts*
that depends on the suitability of a method to predict the general pattern of time series and to decern turning points.

2.1.1.3 Supplementary Factors

The evaluation of forecasting methods has to be extended to a number of complementary - mainly psychological and economic - factors. They include the
- *comprehensibility* and *acceptability* of the method
and the
- *applicability/relevance* of the results
for specific needs of the users as well as the
- *costs*
connected with the introduction (hardware/software) and operation (manware) of the proposed forecasting technique.

2.1.2 Model Presentation

The hierarchical structure of the evaluation criteria can be represented in various graphical forms. They highlight the general embedment of the attributes within the general model.

2.2 Weighting

The weighting process starts with the
- *determination of local and global priorities* of the attributes
and leads to the
- *evaluation and final ranking* of pre-selected alternative forecasting methods.

2.2.1 Priority Weights for Attributes

Priorities are set for criteria by comparing them in pairs with respect to the anchor element at the immediately higher level of the hierarchy using the standard (1-9) scale. For each set of pairwise comparisons, successive calculations lead to the determination of the local attribute weights (eigenvector of the comparison matrix) and some additional statistical measures (consistency index/ratio).
Figure 1 shows the priorities of the main criteria as a result of pairwise comparions with respect to the goal.

Figure 1. Determination of local priorities: Main criteria

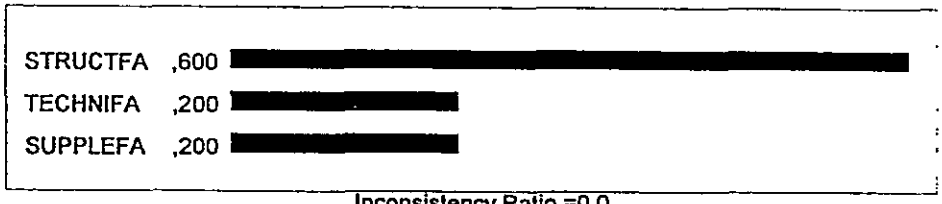
Node: 0

Compare the relative IMPORTANCE with respect to: GOAL

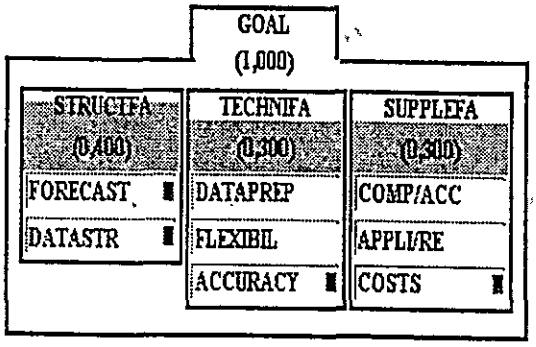
1=EQUAL 3=MODERATE 5=STRONG 7=VERY STRONG 9=EXTREME

1	STRUCTFA	9	8	7	6	5	4	(3)	2	1	2	3	4	5	6	7	8	9	TECHNIFA
2	STRUCTFA	9	8	7	6	5	4	(3)	2	1	2	3	4	5	6	7	8	9	SUPPLEFA
3	TECHNIFA	9	8	7	6	5	4	3	2	(1)	2	3	4	5	6	7	8	9	SUPPLEFA

Abbreviation	Definition
Goal	Evaluation of Forecasting Methods
STRUCTFA	Structural factors
TECHNIFA	Technical factors
SUPPLEFA	Supplementary factors



Inconsistency Ratio =0,0



Similar calculations have to be made for the criteria on the lower hierarchical levels. A synthesis combines these priorities with respect to the goal. The global priorities at the lowest level are basic for the evaluation of the alternatives.

2.2.2 Pre-Selection and Rating of Alternatives

The pre-selection of the forecasting methods presents no special problems. It is advisable to concentrate on pratice-oriented methods and to eliminate techniques and procedures that are of theoretical interest only (infeasible alternatives).
The selected alternatives are to be subjected to a general grading process by means of the
- *absolute measurement technique.*

In its simplest version it leads to the assignment of decimal numbers between 0 and 1 representing the fraction of the highest rating an alternative could receive under a specific basic criterion. .
The final ranking of the alternatives indicates that Exponential Smoothing is the most preferable technique under the set circumstances. See Figure 2.

Figure 2. Ranking of forecasting methods, partial view

	Alternatives	TOTAL	STRUCTFA-FORECAST-HORIZON-H-SHORT .1008	H-MEDIUM .0504	H-LONG .0168
1	Extrapolation, mean forecast	0,852	GOOD	UNSATIS	UNSATIS
2	Moving average	0,936	V. GOOD	UNSATIS	UNSATIS
3	Exponential smoothing	0,948	V. GOOD	GOOD	BLW AVG
4	Classical decomposition	0,888	V. GOOD	V. GOOD	GOOD
5	Census X-11	0,908	V. GOOD	V. GOOD	GOOD
6	Identification, univariate	0,905	V. GOOD	V. GOOD	GOOD
7	Identification, multivariate	0,900	V. GOOD	V. GOOD	GOOD
8	Adaptive filtering	0,896	V. GOOD	V. GOOD	GOOD
9					
10					

Based on these results the evaluation process could be repeated with respect to sectionalized subsets of the highest ranked alternative (such as linear exponential smoothing according to Holt/Brown/Winters/.). This approach is generally well accepted in practice and furthers cooperation with scientific advisors.

3 Selection of Forecasting Software

The evaluation process strictly follows the standard AHP methodology.

3.1 Modelling

The model-building process is characterized by the inclusion of
- *software-supported forecasting methods*

and some additional
- *input, output and system oriented criteria.*

See Table 2 for details about the realized model structure..

Table 2. Evaluation criteria: Forecasting software

```
Evaluation of Forecasting Software
1     Input
2     Data Analysis
      - Graphical
      - Mathematical
3     Forecasting
      - Extrapolation
          - Mean forecast
          - Moving average
          - Exponential smoothing
      - Decomposition
          - Classical decomposition
          - Census II systems
      - Identification
          - Univariate
          - Multivariate
      - Adaptive filtering
4     Output
      - Appropriateness
          - Amount of data
          - Timing
          - Form
5     System
      - Cost
      - Reliability
      - Support
          - Manuals/newsletters
          - User groups
```

3.2 Weighting

The results of the attribute evaluation are partially shown in Figure 3. The local priorities assigned to the forecasting methods in general (.600) and the extrapolation and exponential smoothing methods (.650; .800) are bound to lead to a corresponding high global evaluation of the latter technique (.312). The global priorities of all the attributes considered in the evaluation process are shown in Table 3.

The weighting of the alternatives can be restricted to a

- *small number of software packages.*

They can be selected on the basis of Software Reviews and other relevant sources that are periodically published in the American/European literature. Under such conditions, it is possible to use the

- *relative measurement technique.*

It is characterized by the determination of the priorities of (criteria, subcriteria and) alternatives by comparing them relative to each other rather than against a previously established (e.g., 0-1) grading scale as in the case of absolute measurement.

In the current example the actual evaluation process has been limited to

- *three software packages.*

See Figure 4 for a graphical representation of the final results of the evaluation process.

4 Summary and Conclusion

The AHP methodology has been sucessfully used for the evaluation of forecasting methods and software in a number of case studies in various fields (sport and medical centers, pharmaceutical industry, etc.). The examples presented in this report have been adapted from these studies and simplified for the actual study. They clearly indicate that practice-oriented applications of the AHP methodology call for the use of adequate software systems such as
- *Expert Choice for Windows 9.0*
or comparable products (AutoMan 2.0, Criterion DecisionPlus for Windows, etc.).

Figure 3. Local priorities of attributes, partial view

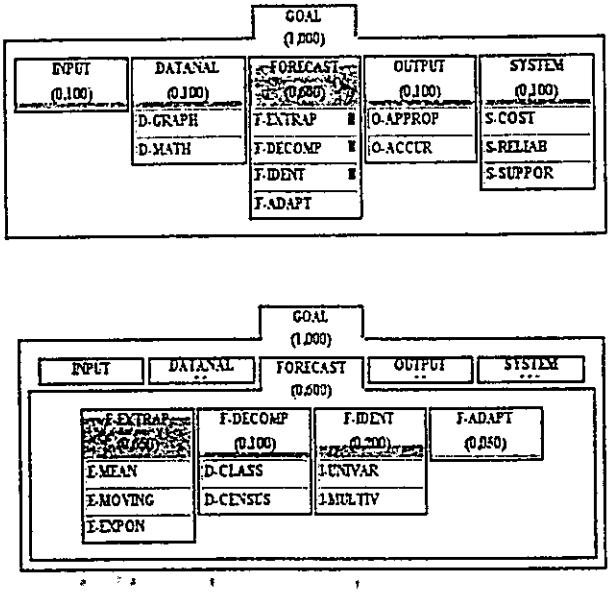
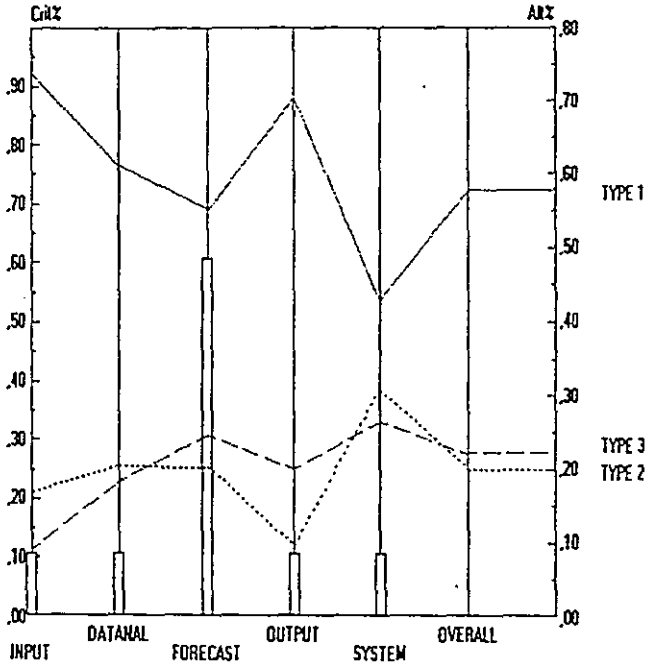


Table 3. Global priorities of attributes (with respect to GOAL for nodes below GOAL)

Synthesis of Leaf Nodes with respect to GOAL
Distributive Mode
OVERALL INCONSISTENCY INDEX = 0,0

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5
INPUT =,100				
DATANAL =,100				
	D-GRAPH =,030			
	D-MATH =,070			
FORECAST=,600				
	F-EXTRAP=,390			
		E-MEAN =,020		
		E-MOVING=,059		
		E-EXPON =,312		
	F-DECOMP=,060			
		D-CLASS =,003		
		D-CENSUS=,057		
	F-IDENT =,120			
		I-UNIVAR=,102		
		I-MULTIV=,018		
	F-ADAPT =,030			
OUTPUT =,100				
	O-APPROP=,030			
	O-ACCUR =,070			
SYSTEM =,100				
	S-COST =,020			
	S-RELIAB=,070			
	S-SUPPOR=,010			

Figure 4. Performance sensitivity graph



Abbreviation	Definition
INPUT	Input
DATANAL	Data analysis
FORECAST	Forecasting
OUTPUT	Output
SYSTEM	System

TYPE 1	Software package 1
TYPE 3	Software package 3
TYPE 2	Software package 2

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