FORECASTING OF COST INDICES IN THE GREEK CONSTRUCTION INDUSTRY: A JOINT METHODOLOGY APPROACH

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Forecasting is the process of estimating or predicting the future. The principle aim is to provide reliable estimates of future business that will assist management in making accurate decisions and sound plan for the future. Essentially, there are two main approaches to forecasting - subjective and objective approach. The subjective approach incorporates the judgement of 'experts' (persons who work closely with the industry or product they are set to forecast). The objective approach applies a scientific process to the analysis of previous data using a statistical approach to create 'a fit' to the historic data then applying the 'model' to predict future occurrences. There have been several attempts to see whether analytical mapping can indeed outperform the judgement of experts and vice versa. However, studies have shown that combination methods, which combine subjective and objective approaches, are more comprehensible. The objective of this paper is to forecast cost indices in the Greek construction industry using a forecasting methodology, which has been developed during the course of this research. The methodology combines analytical process of forecasting with judgmental input to tune and adjust forecasting figures. It is concluded that such a methodology can improve forecasts and provide managers with a vital tool to analyse historical data. The methodology is encapsulated in a form of a computer program.

Keywords: cost indices, forecasting, Greek construction industry

INTRODUCTION

The principle aim of any cost forecast is to provide reliable estimates of future business that will assist management in making accurate decisions and sound plan for the future. Essentially, there are only two forms of approach to forecasting: Subjective, which incorporates the judgement of 'experts' (persons who work closely with the industry or product they are set to forecast). Objective, which apply a scientific process to the analysis of previous data using a statistical approach to create 'a fit' to the historic data then applying the 'model' to predict future occurrences.

Forecasting performs most effectively as a two stage process with trends extracted from historical data and subjectively analysed by an expert estimator (Bates and Dawood,1996). There have been several attempts to see whether analytical mapping can indeed outperform the judgement of an expert and vice versa (Edmundson, *et al.*1988). However, numerous publications have shown that combination methods are undoubtedly the most comprehensible (Bunn and Wright, 1991; Dawood and Neale, 1993; Pereira *et al.* 1989, Bates and Dawood, 1996). This paper introduces a methodology to illustrate the concept of combining subjective methods and objective techniques in order to produce a reliable cost forecast which is applied to Greek construction cost indices. Objective approaches tend to use historical data and/or

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economic indicators to predict the future. This might be not enough to produce a reliable forecast as current market information and intelligence, and expert opinion is not taken into consideration.

Trends and projections tend to aid the estimator with his prediction as a visual understanding of the past can help users develop the future. To make the process of forecasting simpler, indices can be developed from antecedent data and predicted using a variety of models. Explanations of these modelling techniques appear in several publications (Bates and Dawood, 1996) and are outlined in a subsequent paragraph.

To prevent loss or erroneousness, the knowledge mentioned should be harnessed in an expert system. Forecasting time series information has been made simple with the development of expert forecasting software such as *'Forecast Pro'* and generally by the world of IT (Woodward *et al.* 1994). Complex statistical methods are carried out by the processor without the intervention of the user. This may all seem a little 'black box'. Nonetheless, as the estimator is only interested in a visual or tabular representation of the underlying trends and not the analysis that goes into producing these trends, this only aids the outcome.

Expertise is inherent with an experienced estimator as market feel. However, this feel is difficult to grasp and to put into a logical format. Nevertheless, if it was to be controlled and verified within the construction industry it could be an extremely useful tool in:

Speeding up the experts response to the client

Accelerating the training of junior estimators

Providing a means for encapsulating expert knowledge from experienced personnel.

All of these provide confidence for both the estimator with his figures and the client with an improved and guaranteed estimate and possible reasons for error.

The remainder of this paper discusses and introduces forecasting techniques and a methodology for integrating the subjective and objective styles. The subjective refinement utilised as part of the joint approach is also reviewed. This joint methodology has been applied to actual cost indices data from the Greek Construction Industry.

FORECASTING TECHNIQUES

As aforementioned, there are several techniques available for forecasting time series data. The approaches tend to fall into two overall categories, either analytical or subjective. This section reviews the most common of the techniques available in the business management field.

Review of the subjective techniques

Subjective techniques are those based on the judgement of 'experts'**.** There are several different forms of subjective forecast and they are reviewed in a proceeding paragraph. The techniques are based on the knowledge of the persons working closely with the element they are forecasting. The predictions are usually fairly accurate and should not be considered unusable because there is little or no mathematical background to the theories. In fact a lot of the companies in the UK only use

judgement in their predictions (Bates, 1997) as they found statistical methods to be far more cumbersome, expensive and no more accurate (Sparkes and McHugh, 1984).

Normally the forecasts are produced by people who are directly involved with the item they are forecasting, and have a sixth sense about how they are going to move in the future. The familiar techniques can be found in any judgmental forecasting text (Wolfe and Flores,1990) and are summarised below. Table 1 presents the judgmental techniques:

Table 1: Subjective Forecasting Techniques

SUBJECTIVE METHOD	DESCRIPTION
Sales Force Estimates	Sales force estimating is the method where the salesperson is required to produce an estimate of future movements in the market himself.
The Survey Method	This method is extremely simple to carry out with very little expertise required. Basically it asks customers their opinions.
The Average Judgement Method	Based on the judgement of personnel concerned with the business
Delphi Method	Based on a questionnaire approach given to a panel of experts, were the answers from the first round of the questionnaire are applied to develop the next.
Identification Methods	Based on identifying who the experts are.
Graph And Table Methods	Based on eyeball judgements of previous data, either by graph or by tables of results

Review of the objective techniques

As the prime intent of this paper is to produce a joint approach to forecasting in the Greek Construction Industry, it is best to review the mathematically based methods also. The statistical approaches are the backbone to the conjunctive method with the subjective evaluation being the refining element. The judgmental methods are normally applied to incorporate expert judgement to the analytically forecast data. The most common analytical methods are presented in table 2.

In conclusions, the simple forecasting methods might perform better than complicated methods and almost all objective techniques use the past to predict the future, see Dawood, 1993. In this paper, an attempt to use historical information and knowledge about market behaviour to forecast the future has been made. The next section introduces and discusses the joint approach methodology.

JOINT APPROACH METHODOLOGY

Joint approach methodology is a systematic methodology for applying subjective intervention within a statistical procedure. The model is made up of an objective semi-complex method which allows the use of judgmental intervention, so as to refine and influence the outcome. The procedure to use joint approach methodology and a simple application to the Greek Construction Industry has been presented in this section.

The semi-complex approach utilised is the Classical Time Series Decomposition (Proportionate Model). Decomposition refers to the breaking down of the data into workable components, then aggregating the prediction of each component to form an overall prognosis using Equation 1 Classical and can be carried out by following the steps discussed .

Table 2: Objective Forecasting Techniques

OBJECTIVE METHOD	**EQUATIONS**	**DESCRIPTION**
Moving Average Models	$\hat{Y}_{t+1} = \frac{(\sum_{i=0}^{N-1} Y_{t-i})}{N}$	This approach is ideal for finding seasonal effects, by smoothing the peaks in the actual data
Smoothing Models	$\hat{Y}_{t+1} = \alpha Y_t + (1-\alpha)\hat{Y}_t$	This group of models is based on the equation(left) that can be used to smooth the actual series, the trend and the seasonality depending on which model.
Decomposition Models	Y = T * S * C * I	This model breaks up the data into workable components, which are easier to forecast, however requires some expert intervention
ARIMA Models / Box Jenkins	$z_t = f_1 z_{t-1} + \ldots + f_p z_{t-p} + a_t - t_1 a_{t-1} - \ldots - t_q a_{t-q}$	This is a very complex set of models which are made up of auto-regressive components and moving average components based on the generic equation(left)
Causal Models	$Y_I = b_0 + b_1 X_i + b_2 X_{2i} + b_3 X_{3i} + \ldots + b_k X_{ki}$	These models are moving away from the projectionist type models by considering the factors that influence the overall factors movement
Learning Models	$\hat{Y}_{t+1} = \sum_{i=1}^{N} w_i x_{t-i+1}$ $Y = \sum_{i=1}^{k} \alpha_i f(\sum_{j=1}^{n} \gamma_j X_j)$	These models fall into two categories where the weights applied to the actual series for learning or as weights to the influencing factors. (Neural Networks)

Y = T * S * C * … Equation 1 Classical Time Series Decomposition

Where, Y = actual series; T = trend; S = Seasonality; C = Cyclicality; I = Randomness

The trend may be extracted by using least squares regression.

The seasonality produces seasonal variations about a unity value and also reduces some of the randomness of the series. The stages required to achieve the values are as follows:

Find the moving average of the data (using a suitable seasonal period such as twelve months)

Divide the actual historical indices by the moving average values for the same period

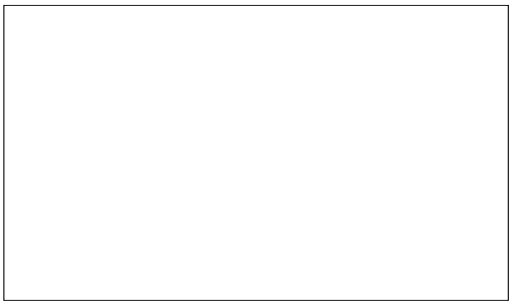
Find the average seasonal factor for each period over the whole term

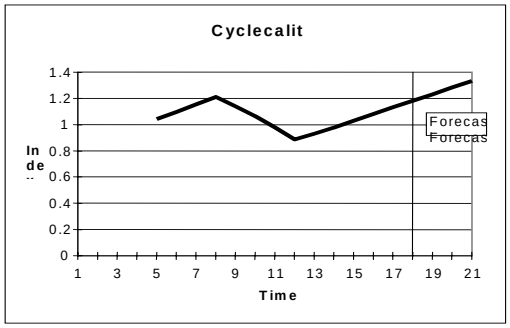
Normalise the seasonal factors (by multiplying them by the reciprocal of the mean of the factors calculated in 3.)

The cyclicality, which represents the ups and downs in the economy and the general movement of the business cycle (still including some randomness) is calculated as follows:

Cyclicality = Moving average / trend ..Equation 2 Cyclicality

			c=	481.7	
			m=	-9.31	
93-96					
Quar	**1510**	**Trend**	**Moving**	**Cy,MA/T**	**Forecas**
1	434.1	472.4			
2	442.0	463.1			
3	462.8	453.8			
4	476.4	444.4			
5	491.0	435.1	453.86	1.0429362	453.86
6	496.8	425.8	468.1	1.0991617	468.1
7	509.8	416.5	481.797	1.1566100	481.79
8	317.6	407.2	493.557	1.2119275	493.55
9	330	397.9	453.85	1.1405111	453.85
10	327.6	388.6	413.587	1.0642191	413.58
11	338.5	379.3	371.292	0.9788371	371.29
12	347.3	370.0	328.467	0.8877260	328.46
13	362.6	360.7	335.892	0.9312240	335.89
14	364.4	351.3	344.047	0.9791044	344.04
15	366.2	342.0	353.232	1.0326020	353.23
16	373.6	332.7	360.1	1.0822790	360.1
17		323.4	366.7	1.1337723	366.7
18		314.1		**1.1837723**	**371.88**
19		304.8		**1.2337723**	**376.10**
20		295.5		**1.2837723**	**379.39**
21		286.2		**1.3337723**	**381.75**





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11	338.5	371.2
12	347.3	328.4
13	362.6	335.8
14	364.4	344.0
15	366.2	353.2
16	373.6	360.1
17		366.7
18		371.8
19		376.1
20		379.3
21		381.7

Figure 1: Main components of the decomposition method Forming the forecast

Figure 1 shows the main components of the decomposition method applied to a cost index in Greek Industry.

Once the seasonal factor is identified, the trend is calculated and the cyclical factors are estimated, the forecast is the aggregating the components as shown in equation 3.

Forecast (t)= Trend (t) * seasonality (t)* Cyclicality (t) *Equation 3 Forecast*

An element of judgement is applied to the forecast of the cyclicality as shown in the following section.

Subjective intervention
The subjective intervention is applied by forecasting the cyclicality that can have up to 40% on the forecast. Two different approaches have been used, the first is to use the Delphi and Identification methods (mentioned earlier in this paper) to forecast the cyclicality to be incorporated in the overall forecast (equation 3), the second is to use weighted average risk factors. The latter uses aggregation of influences to predict cyclicality as shown in equation 4.

$$\textbf{Cyclicality} = 1 + \left[\sum_{K=1}^{M} \phi_K \times E\left[MR\right]_K \right] \ldots \quad .. \qquad \textit{Equation 4 Cylclicality Movement}$$

where, ϕ_K Represents the weightings of each of the factors

$\mathbf{E[MR]_K}$ Represents the expected addition value for each factor found through knowledge elicitation.

The component inside the squared braces represents the variation about the unity value for cyclicality as an addition or subtraction. Furthermore, until these factors have been investigated a detailed evaluation such as this cannot be carried out.

The paper is focused on using the Delphi and Identification method to forecast cyclicality. In this method the experts (Engineers and Consultants) were asked to prepare a forecast of the cyclicality for 12 different cost indices and asked to specify their confidence in the results. This is used later to assign weighting for each expert. The outcome of this process is a weighted average of the cyclicality of each index.

All the methods outlined in this paper have been included in a knowledge based system known as TAROT which utilises a statistical forecasting package known as Runes for Excel and MSACCESS databases to formulate the forecasts mentioned. The following section discusses the case study used in this paper to explain the methodology.

FORECASTING IN THE GREEK CONSTRUCTION INDUSTRY

The historical data that is used in this paper is cost values of activities (cost of laying square meter of sub-base for major roads) and published by the Greek Ministry of Economy. The indices are fairly sensitive to economical factors such as inflation, changes in prices of materials (like petrol, cement, tyres), changes in employment fees as well as changes in taxation or interest rate. The indices are used by Greek Cost Engineers to estimate projects and by some contractors to calculate accurately the discount price in order to enter a tender submission process.

Figures 2, 3 and 4 show the analysis of one of the cost indices.

CONCLUSIONS

From visual inspection of the graphs and table above it is obvious that accuracy is not directly related to complexity with regard to forecasting with the joint approach comparing well with some of the complex methods but with greater understanding.

Further, combination forecasts leave the necessary room for improvement and show that a little judgement can improve the accuracy significantly. The expert opinion alone tended to underestimate the situation especially the seasonal jump in the data.

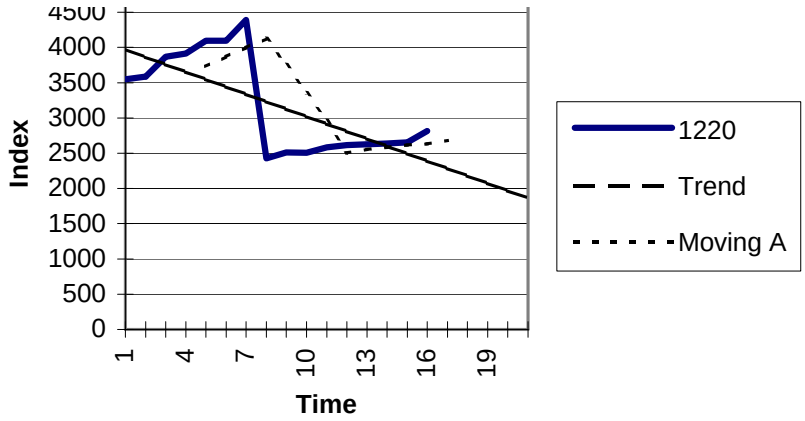

Figure 2: Analysis of cost index 1220

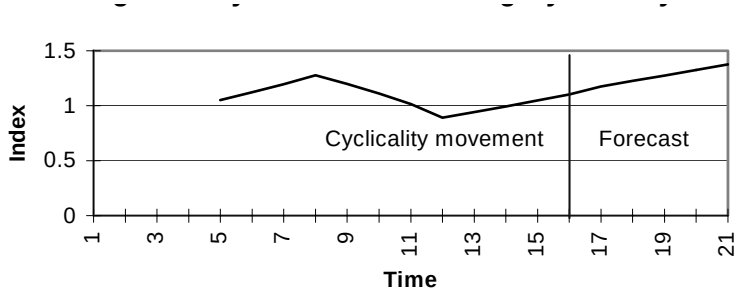

Figure 3: Analysis and forecasting cyclicality

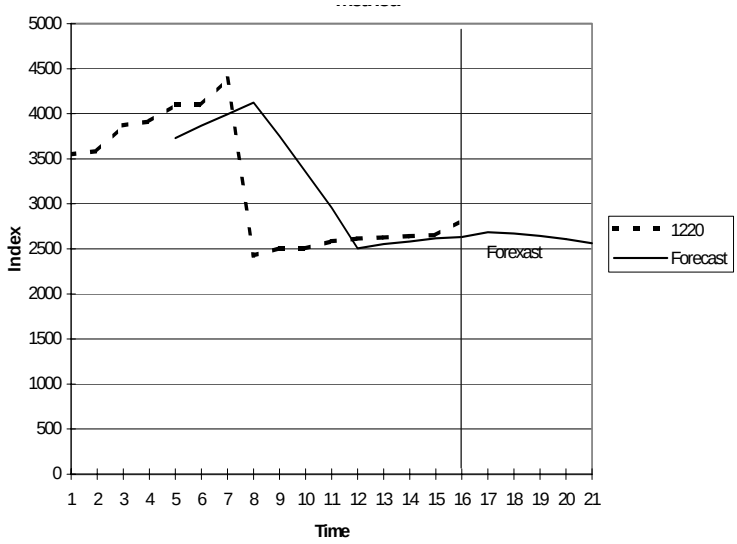

Figure 4: Preparation of forecast for index 1220 using the decomposition method

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