A Computer Based Decision Support System For Ethical Investments For Indigenous People

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Abstract: Planning and capacity building by indigenous peoples requires insight into the problems they may face in accumulating wealth and providing for their well-being. Some of these problems include low educational levels, barriers to entry in business, and low decision-making capacity. An interactive computer decision support system was created to assist New Zealand Maori Trust Boards to make sound financial investments and to provide a sustainable future. The system has two parts; (1) selecting investments by performance, and; (2) identifying the wealth per capita. The selection criteria is based on a simple multiple objective scoring method that assesses a companies performance economically, environmentally, socially, and culturally to meet the specific values of Maori custom and for business success. The second part of the model is linked to a custom-made population scenario planning model to project future returns and wealth per capita. The model produces two reports, of which one is projections of future wealth per capita from the years 2001 to 2051 under the nine scenarios. The second report displays investment performance against financial, economic, social, environmental and cultural goals.

Key words: Maori; Ethical investment; Decision support

1. INTRODUCTION

Maori people (indigenous to New Zealand) as with other indigenous cultures have been subject to the pressures of marginalisation through the development process, and the detribalisation of governance structures. Maori have been ill prepared for a market economy. For decades, government formed institutions have been imposed on tribal organisational structure handicapping Maori indigenous people in decision-making [Iremonger and Scrimgeour, 2001a].

The purpose of this model is to help Maori Trust Boards and other institutions to make sound decisions, based on financial, economic, social, environmental, and Maori cultural values through the use of a computer-based decision support system and to assist in the sustainable development of Maori.

This paper explains the background issues and mechanics relating to the creation of the Investment Viability Model (IVM) prototype model, which the authors designed to facilitate decision-making based on Maori indigenous people ethics and values.

2. AIM

In creating the IVM model strict specifications were adhered to. These include:

- Low cost to Maori institutions
- Easy to use and understand
- Reflect Maori cultural values
- Reflect sustainable environmental, social, economic and financial values
- Aid in rapid tribal learning through the various forms of Maori institutions.
- Incorporating wealth generated per capita under different population scenarios for future planning.
- Identifying break-even analysis
- Incorporating past and future time factors for new "start-up" and existing investments
- Identify performance of each investment
- Incorporate preferential ranking regimes amongst different investments.

3. METHODOLOGY

3.1 Values Framework and Decision Modelling

In examining the specifications, and budget constraints the task seemed rather ambitious, and required identifying what resources were available to the project team. Research had already been done in gathering Maori values. Maori values and tribal resources were collected by tribal researchers using participatory planning and group decision making techniques, and was able to be used for structuring and visualisation purposes (Loomis, et. al.].

For important investment decisions to be made information gathering and monitoring is required. Recognising that many Maori organisations had low research and resource capacity, the authors assumed that many investment decisions were going to be made under uncertainty. Cultural preferences also required that group decision-making needed to be incorporated. Hence the Analytical Hierarchy Process [Saaty, 1980] of decision analysis was used in incorporating broad cultural (tikanga), social (whanunatanga), environmental (kaitiakitanga), and economic (putea) values and indicators into the model.

The AHP method requires establishing and overall fundamental objective. This was taken to be "Maori Sustainable Development" which defined as ensuring that desired Maori "culture, environment, society, and economy" be sustained into the future.

After the values of the Maori tribes that participated in the project were collected an objectives hierarchy (Figure 1) was formed in order to structure the decision problem and to identify multiple objectives. The entire objectives hierarchy cannot be shown due to space constraints for the paper.

Following this exercise a set of criteria questions were formed based on the values of the Maori tribes, and attributes to measure the performance of each investment under each criteria question. The questions also reflect the risk –adverse nature of Maori values. In total there are 54 criteria questions, along with 9 operational ratios and financial performance measures that are used to analyse the financial performance of an investment.

Pairwise comparisons have been made in participatory planning workshop with Maori tribal members to compare how much one criteria or objective is preferred to another for prioritisation purposes using the scale suggested by Saaty [1980].

These criteria questions were inputted into weightings matrices A_e, A_s, A_c, A_{mk}, A_{cw}, A_{op}, *and* A_{obj}. Problems with rank reversal of the AHP method by Saaty (1980) lead to its revision in which the geometric mean technique was favoured before and arithmetic mean prior to averaging across the square of each matrix A_x^2 and normalisation to get weightings for each criteria under each objective.

The environmental matrix A_e holds preference data on environmental criteria. Similarly, the social A_s, cultural A_c, marketing A_{mk}, credit worthiness A_{cw}, operational ratios A_{op}, and objectives A_{obj} matrices contain the preference data of their corresponding criterion questions.

Attributes were weighted after all possible feasible outcomes to a criteria question were established. Because quantitative and qualitative information was used to describe model attributes and they had different measuring units, it was necessary to place all attributes on a similar scale.

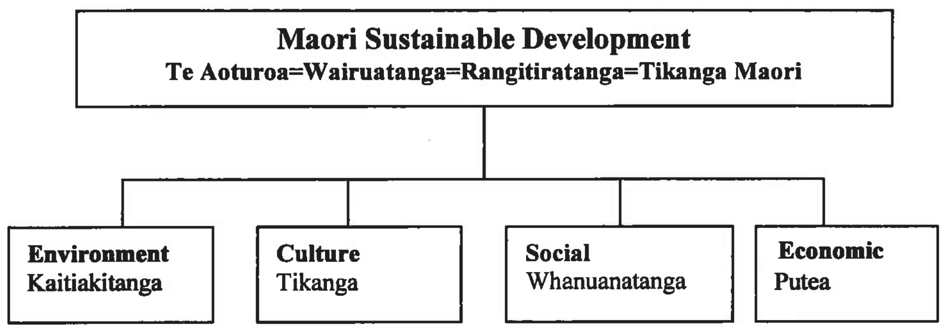

Figure 1 Broad Objectives Hierarchy for the IVM model [Iremonger , 2001]

3.2 Scoring

Scores for each criteria question could them be calculated by multiplying the weighting and the attribute scores together.

$$Sx = w.a \tag{1}$$

Where Sx is the score for criteria question x, w is the weight and a is the attribute score.

Sub-objective scores (apart from the economic sub objective) are calculated by summing the score fore each criteria question (Sx) under each sub-objective category:

Environmental score (Env_{score}) $=\Sigma S_x^{env}$
Social score (Soc_{Score})$=\Sigma S_x^{soc}$
Cultural score (Cul_{score}) $=\Sigma S_x^{cul}$

The economic viability data has three separate sub matrices containing marketing, credit worthiness, and operational ratio information.

Operational ratio attributes were scored differently, by requiring that the ratio exceeded a nominal target ratio before a score could be granted.

The operational ratios included calculations of business profitability, financial stability, and resource utilisation (Table 1) by David [1995]. The authors realise that financial information from some businesses maybe reported differently for each business. For consistency, the decision maker would need to input profit and loss and balance sheet information for each investment.

Table 1: Operational Ratios

Business Profitability
Gross profit margin=Gross profit/turnover
Net Profit margin=Net profit (after tax)/ turnover
Return on Equity=Net profit (after tax)/owners equity
Financial stability
Current ratio=Current Assets/ current liabilities
Debt equity ratio=(Total Assets-Owners equity) / owners equity
Quick ratio=(Current Assets-Inventories) / Overdrafts
Resource utilisation
Total asset turnover=Turnover/Total Assets
Inventory turnover=(Cost of goods-Inventory)/ Inventory
Debt turnover=Credit/debtors

Source:[David, 1995]

Total Economic score (Eco_{score}) equals the sum of the marketing score, creditworthiness score, and operational ratio score multiplied by the weight for the economics objective (Ec_{weight}) and weighted profitability score (Π_w).

$$Eco_{score} = (\sum (Mk_{score} + Cw_{score} + Op_{score})) x (Ec_{weight} x \Pi_w) \tag{2}$$

Scores for each sub-objective were calculated by tallying up the scores for each criteria question.

Total score (T_{score}) for an investment is calculated, by incorporating information about a tribes preferences established through pairwise comparison exercises to get weightings for the social, environmental, economics, and cultural sub objective (W_{env} , W_{soc}, W_{cu}, W_{eco}) using the AHP method for aggregation as a basis, then multiplying the scores from each adding the economic score calculated previously.

The total score is:

$$T_{score} = Env_{score} x W_{env} + Soc_{Score} x W_{soc} + Cul_{score} x W_{cul} + Eco_{score} x W_{eco} \tag{3}$$

3.3 Breakeven Analysis

Break-even analysis was used to establish times and quantities that need to be sold for a given sales forecast, before the investment starts making a profit.

On a simple level, break-even analysis was done by calculating all the costs (Ct) involved in a investment, calculating the annual turnover (T/o), take cost of sales ($Csales$) and operating expenses ($Oexp$) away to get gross profit (Πg), minus tax (t) and loan repayments (L) to get the net profit margin (n). From the net profit margin, and dividing by quantity to sell (q) to get a raw cost price, dividing by a price (p) to get the quantity to sell, or dividing by net profit margin (n) to determine the time till break even using concepts from Benninga, [1999].

Return on Investment (Re) is calculated by taking the net annual profit minus (n) any loan repayments (L) divided by investment equity (Inv), and multiplied by 100 to get a growth rate.

$$R_e = (n - L/I_{nv}) x 100 \tag{4}$$

3.4 Wealth

Specific information regarding an investment's financials are analysed using operational ratios, breakeven analysis, and internal rate of return.

Return on Investment (R_e) can only be inputted only for one year at present. However future versions of the model will enable historic financial data on company's performance could through regressions to form a trend line for time-series analysis when the information comes available.

In this model wealth is represented only through monetary capital. Return on investment (R_e) and total population size (P_t) at any time interval is used to calculate a wealth per capita (W_p) through out time intervals under different population scenarios generated by PopulationMOD (created by the authors). Obviously, inflation rate (I_n) and the interest rate (i) can also affect the overall return on investment. Inflation is subtracted from the return as it reduces the purchasing power throughout time, whereas the interest rate has the reverse effect.

$$W_p = \frac{I_{nv\,0}(R_e + (i - I_n))}{P_t} \qquad (5)$$

where I_{nv}= Initial investment

Wealth is calculated for 5 and 10 years into the future. New investments would need to incorporate possible sales forecasts for marketing plans over a 5 to 10 year time period and can be putted into a database. Population scenarios will be used to determine potential growth areas for markets investment.

3.5 Computer Framework

The IVM1 model prototype was created on Excel using VBA object-orientated programming. The model will eventually be incorporated into a larger environmental accounting and planning software package being developed by the authors for sustainable development, using C++ programming.

The proto type for the IVM model (IVM 1) was first established using object -orientated design under the VBA editor in Excel.

In order to establish a user-friendly interface, user-forms were designed to incorporate easy operations by the end users (ie tribal decision makers) using simple click command buttons. There are nine user-forms in the model and 8 multipages placed on the main form collecting Investment data

In total there are six reports that can be generated from the program in print preview. A "Weightings Report" shows the weightings of all objective and criteria questions after preferences have been inputted. The "Operational Ratio Report" that shows a more quantitative measure of the economic performance of the investment.

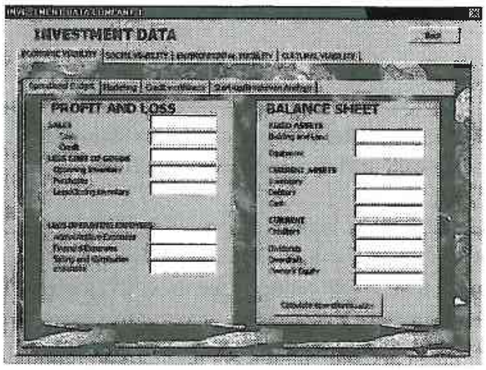

Figure 2: Profit and loss/balance sheet userform [Iremonger and Scrimgeour, 2001b].

A "Breakeven Analysis Report" that shows minimum sales, prices, and time required to breakeven from the investment.
"Summary of Performance" shows the economic, social, cultural, and environmental scores for the business, plus other vital economic information. "Wealth per capita report" shows the wealth generated per person under different population scenarios, and Wealth per capita graph report.

3.6 Testing the Model

As part of the development process for the design of the IVM model, it was necessary that end users were agreeable to the design of the model and that it was technically and conceptually in line with Maori ethics and investments for sustainable development. This process was also necessary to ensure that the modellers' understood the Maori values, ensure the model was user-friendly, and allow participation, and transparency in the development of the model.

Initial tests on the model were done initially through a small group of lead users from the four Maori Trust Boards collaborating in the Maori Sustainable Development Project in te Puku o te Ika, and a small group of academics (including scientist, planners, economists, and other researchers). The users were instructed about the potential benefits and uses and had a small introduction to how it worked. After the instruction, the users were told basically to find any fault technically and conceptually with the model.

After an hour of examining the model, the group was asked if they found any faults through the process of group inquiry and were asked to brainstorm on what would make the model user-friendly.

After the initial group session, the four Maori Trust boards were given a CD-ROM copy of the IVM model for a 30-day evaluation period and have been asked to comment on it.

4. DISCUSSION

4.1 Testing

From the initial group testing session all users were in agreement for the use of the AHP method being used to analyse investments according to Maori values. The representatives from the Maori Trust Boards were especially pleased about the potential benefits in selecting investments.

Some technical suggestions include retesting with present data, slight changes to the userform design, and adding a definition of scale for the scores.

On a conceptual level, the users asked what would happen if a criteria question was not relevant, changing time factors, incorporating visual presentation of results instead of statistics, and trade- off decisions between different forms of capital.

4.2 Scoring And Scaling

Although this model is already useful there is room for design improvement in the model as previously mentioned. The total scores for each investment can be analysed further to establish a more coherent scale for comparisons.

The issue of irrelevant questions will be treated as if it had equal preference with 1 in the pairwise comparison. The reason for this, is that it assumes that the decision makers have no preference "for or against" the criteria question. An attribute score of 0 will be given to the irrelevant criteria question, to make it void from the rest of the calculation. It was the authors intentions to make the questions as general as possible so that they were able to be used over a wide range of investments.

4.3 Breakeven Analysis

It was noted by the authors that the treatment of data in break-even analysis has to be changed. The reason for this is to allow time-series data about investment performance to be inputted into relational tables in Access, and analysed, as it is difficult to structure data in different tables readily in Excel. A linkage will then be made between the Access database and Excel file using VBA programming.

4.4 Wealth And Trade-Offs

Trade-offs can be represented by the weights on each sub-objective. Trade-offs can be used to represent changes in the natural, social, cultural, and economic capital.

Total wealth (Wt) of a Maori tribe will obviously include other forms of capital (such as natural (K_n), social (K_s), human (K_h), cultural (K_c) and economic capital (K_{ec}). Total Wealth is calculated using a variant on Hamilton [2000] equation for wealth by including culture, natural, and social capital in place of health, education investment, and research.

For consumption C as measured in a system of tribal account, depreciation (D), depletion (D_p) and total wealth Wt, the calculation proceeds as follows:

$$\Delta Wt = Kec + Kn + Ks + Kh + Kc$$
$$- C - D - Dp \qquad (6)$$

The NPV of wealth is:

$$Wt = \sum \frac{K_x(1+r)^t}{(1+i)^t} \qquad (7)$$

Here i is the consumption rate of interest, while r is the rate of growth of per capita consumption. These estimates are then plugged into equation along with the percentage growth in population (g_p), to yield the change in wealth per capita.

$$\Delta\left[\frac{Wt}{Pt}\right] = \frac{Wt}{Pt}\left[\frac{\Delta Wt}{Wt} - \frac{g_p}{Pt}\right] \qquad (8)$$

At this present stage of development the model does not include total wealth changes (Wt') and Total wealth rates (Wt"). Future versions of the model will include dynamic modelling of capital flows..

The scoring of environmental, social, cultural, and economic objectives in this model will be used as a basis for depreciation, consumption, or return on natural, social human, and cultural capital once stock inventories have been established and flows calculated.

Another computer model (SUSTPORTFOLIO) is also being developed by the authors, and uses the Markowitz model, simplex and non-simplex methods for determining the optimal portfolio of investments for social, cultural, natural, and economic capital. Eventually IVM, SUSTPORTFOLIO, and Population-MOD will be combined into one suite of computer programmes.

4.5 Group Decision Making

The IVM model at present incorporates only a group mean for preferences in pairwise comparison. A group preference database, holding information for each individual decision maker's preferences will need to be kept for each Maori tribe. Turroff, and Hitz, [2001] have used computer-based group decision making in the delphi process, so that may require some investigation

5. CONCLUSION

In conclusion the IVM model is still being developed with current work creating databases and structuring the computer program. However the potential benefits of the model will be significant, as it will help ethical decision-making across organisations within Maori tribes, which have been prone to detribalisation, and lack the resources to research investment decisions.

The IVM model also plays an important role in the development of environmental accounting software for investment and planning purposes for sustainable development.

The model can be adapted for other indigenous people, corporations, multilateral agencies, and non-government organisations, that are spread geographically, and wish to have consistency in ethical investments for sustainable development.

6. ACKNOWLEDGEMENTS

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7. REFERENCES

Benninga, S. *Financial Modelling,* The MIT Press, London, 1999.

David, F.R. *Concepts of Strategic Management*, Fifth Edition, Prentice Hall, New Jersey, 1995.

Hamilton, K. *Sustaining Economic Welfare: Estimating Changes in Wealth per Capita,* World Bank, Washington. 2000.

Iremonger, C. Decision Making Models for Maori-Literature Review, Department of Economics, University of Waikato, Hamilton New Zealand, 2001.

Iremonger, C. and F. Scrimgeour. Maori, the Crown and Governance and Management of Assets, Department of Economics, University of Waikato, Hamilton, New Zealand, 2001a.

Iremonger, C. and F. Scrimgeour. Investment Viability Model (IVM): An Ethical Investment Computer Model for Sustainable Development Version 1, Department of Economics, University of Waikato, Hamilton, New Zealand, 2001b.

Loomis, T. J. Gibson, G. Harmsworth, D. Marsh, J. Pene, F. Scrimgeour, and K. Barclay-Kerr, Annual Report on Maori Sustainable Development in Te Puku o Te Ika, University of Waikato, 2000.

Olson, D.L. *Decision Aids for Selection Problems*, Springer series in Operational Research, Springer, New York, 1997.

Saaty, T.L. quoted in Olson, D.L., 1997, Decision Aids for Selection Problems, Springer series in Operational Research, Springer, New York. 1980.

Saaty, T.L. *The Seven Pillars of Analytical Hierarchy Process*, University of Pittsburg, Pensylvannia, 2000.

Turroff, M. and S. Hitz, *Computer- based Delphi Processes*, Web page http://eies.njit.edu/~turoff/Papers/delphi3.html, 2001.