A multi-criteria approach to local tax planning

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Abstract:
A city tax model based on the analytic hierarchy process is developed. This model allows city officials to explicitly take into account the existence of multiple decision criteria in selecting new tax options. Opinions from tax experts are used to relate tax plans to decision criteria. The paper explores the feasibility of applying commonly available decision tools to facilitate and improve decision making in local government.
Keywords: Tax planning; Multi-criteria decision making; Analytic hierarchy process; Delphic hierarchy process

Article:
1. Introduction
Public officials are increasingly faced with situations of rising demand for services, surging costs of providing these services, and a revenue base that, at best, increases at a much lower rate than demands and costs. Possible strategies in such situations include cutting some existing services, improving organizational productivity, and identifying new tax resources or expanding the use of existing ones [1]. While improving organizational productivity is an extremely valuable approach in a time of fiscal retrenchment (see, for example, [2]), the current paper focuses on the third strategy, i.e., the enhancement of a public organization's revenue base through a systematic approach to revenue planning. In any situation, deciding on the mix of revenues that will be used to pay for a local government's goods and services is one of the most important and challenging decisions facing public officials. In designing an equitable and efficient tax structure, local officials must choose from a variety of potential revenue sources needed to meet the needs of the community. Further, they must make that selection after assessing the potential consequences of those revenues on a host of important criteria. Identifying these criteria is a key step in revenue planning.

Almost every writer in the field of public finance has something to say about the criteria that can be used to evaluate a revenue system. Pechman [3] thus argues that taxation has three basic goals: (1) to transfer resources from the private to the public sector; (2) to distribute the cost of government fairly by income class and among people in approximately the same economic circumstance; and (3) to promote economic growth. Rostvold [4] suggests four maxims of a socially acceptable revenue system: (1) compatibility with the social values that govern the general social process; (2) fiscally adequate, broadly based, stable in yield, and balanced in fiscal incidence; (3) administratively simple, economic to administer, with clearly defined tax bases and tax-rate structures; and (4) minimally adverse effects on economic productivity, resource allocation, and the levels of employment, income, and output. More recently, Bahl [5] has suggested five criteria: (l) yield, (2) equity, (3) neutrality, (4) administrative ease, and (5) political feasibility. Other possible criteria include fairness, certainty, convenience, efficiency, productivity, and neutrality [6]. Mikesell [7] has proposed that the criteria of vertical and horizontal equity, economic effects, collectability, and adequacy of revenue production should be used to assess potential revenue sources. Clearly, many of the criteria mentioned here refer to the same or similar concepts, or, at least overlapping notions.

Consolidating and rewording the above findings yields the following list of criteria that can be used to evaluate potential revenue sources:

1. legality;
2. administrative feasibility;
3. social and political acceptability;
4. productivity or yield;
5. horizontal equity;
6. vertical equity;
7. stability;
8. regulatory neutrality;
9. compatibility with strategic plan.

Identifying the essential evaluation criteria is only one step in developing a local government tax model. A further step is to assess the relative importance of each criterion to the overall good of the community, given a specific political environment or context. Another element in an overall tax model involves the identification of potential revenue sources, i.e., potential taxes, which then must be matched to the decision criteria, either individually, or in the form of alternative, composite tax plans. In other words, a score or rating, whether explicitly or implicitly stated, must be determined for each revenue source or tax plan with respect to each of the decision criteria.

Although the current paper deals with the problem of tax planning, the approach described here and the lessons learned are applicable to other decision problems faced by local governments. The latter typically involve weighing a number of decision criteria against each other. Such decision situations may include area usage zoning, incentive programs for attracting businesses, and budget allocations. In all such situations, elected representatives must make far-reaching decisions with potentially serious political repercussions. Further, expert knowledge is required to assess the likely effects of the decision alternatives.

A number of methodologies for dealing with decisions involving multiple criteria have been proposed in the literature [8] with a multitude of software packages now available (see, for example, [9] and [10]). However, despite this availability, only a few such procedures have been reportedly applied successfully in real decision-making situations; and, only relatively few of the available software packages have been extensively tested. A 1989 review [11] of forty published *multiple criteria decision making* (MCDM) applications reveals that the most commonly used methodologies are *goal programming* (see, for example, [12] and [13]) and its derivations, *outranking methods* (see, for example, [14]), and the *analytic hierarchy process* (AHP) [15]. The study also showed that of the forty published applications, only half involved actual decision problems and decision-makers; the other half described hypothetical applications, mostly with construed problem situations. Further, none of these applications dealt with local tax planning. An extensive and more recent survey of *multiple objective mathematical programming* applications [16] also shows that the majority of published "applications" are hypothetical in nature. Only 58 of the 504 references in this survey describe problems with real data and real decision-makers where the results were actually implemented. Goal programming was the methodology used in 36 of these 58 applications.

Chrisman et al. [17] developed a MCDM-based local government tax model using the interactive multiobjective linear programming approach of Steuer [18]. Although they report that the application was successful, the authors of the current paper sought to pursue a different approach. Mathematical programming (linear and goal programming) approaches require the construction of fairly technical models that may not be intuitively

appealing to elected local government officials. Also, such models require assumptions of, usually linear, relationships between different criteria that may be difficult to justify. The analytic hierarchy process, which has recently received increased attention in the public sector decision-making literature, may be a more judicious approach. A recent issue of this journal [19] focused entirely on public-sector applications of AHP, dealing with problems such as the location of a municipal sanitary landfill, the selection of flood control projects, modeling recreational angler surveys, measuring the environmental impacts of Federal Energy Regulatory Commission projects, evaluating fire protection investment decisions for homeowners, and modeling the graduate business school admissions process in a public university. Many other applications of AHP have recently been reported in this journal as well as in other journals, though none of them has dealt with the problem of local tax models.

Strategic decisions in local government are not usually made by a single decision-maker; rather, a collective of elected officials is involved. An advantage of AHP is that multiple decision-makers can be easily built into the model as another layer of the problem hierarchy. Essentially, each decision-maker solves his or her own decision problem. They are then aggregated into a single model, giving each decision maker equal weight, if so desired, or different weights, if appropriate. A similar strategy can be used to consolidate opinions of multiple experts as to the impact that various tax alternatives may have on specified evaluation criteria.

Yet another reason that AHP was chosen for the current project is the availability of well-tested and user-friendly computer implementations. In a recent comparison of a common spreadsheet package with five commercially available decision support systems [20], Expert Choice, an implementation form of AHP, was rated very highly for both user friendliness and user confidence in the solution process. As described more fully below, AHP is used here to develop a hierarchical model, with the overall tax decision at the top, criteria for evaluating the tax alternatives in the middle, and alternative tax plans at the bottom. Local city officials are used to establish the relative importances of the evaluation criteria to the overall tax decision, while a group of tax experts is used to match the tax plans or revenue sources to the evaluation criteria. The latter is accomplished by utilizing a printed questionnaire.

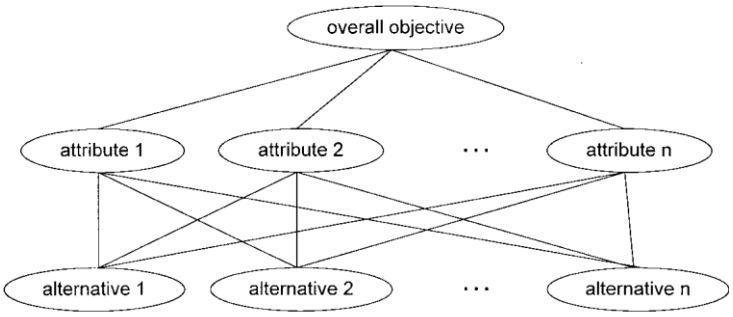

Fig. 1. A hierarchy.

2. The hierarchical model

2.1. The Analytic Hierarchy Process

Given a number of alternatives and a set of criteria or attributes, the basic approach of AHP is as follows (see Fig. 1): An overall objective is defined, and the attributes are evaluated according to their relative impact on the overall objective by pair-wise comparisons. Similarly, each alternative is evaluated according to its relative contribution with respect to each attribute, also by pair-wise comparisons. Evaluations of the alternatives with respect to each attribute and evaluations of the attributes are then combined to generate a utility measure for each alternative, i.e., a measure that indicates the degree to which each alternative satisfies or contributes to the overall objective.

Each alternative, each attribute, and the overall objective are elements of the hierarchy, here consisting of three levels. The overall objective constitutes the highest level (level 1), the n attributes the intermediate level (level 2), and the k alternatives the lowest level (level 3). AHP does not, however, limit us to three levels. For example, each of the n attributes may be characterized by a set of lower level attributes, which, in turn, could be characterized by a set of still lower level attributes, and so on. The lowest level attributes are always linked to

the set of alternatives, which always constitute the lowest level of the hierarchy. Not every element of a level need necessarily be linked to each of the elements of the adjacent levels. If every element is linked to each of the elements of the adjacent levels, the hierarchy is called complete.

2.2. The evaluation criteria

In the introduction to this paper we identified nine decision criteria distilled from the literature. However, *legality* can be viewed as a constraint, rather than a decision criterion, since clearly no illegal revenue sources should be pursued. *Productivity*, or the amount of revenue generated, can also be viewed as a constraint rather than a decision criterion if it is assumed that a certain budget must be met with equal revenues. Given this thinking, seven criteria thus remain:

1. administrative feasibility;
2. social and political acceptability;
3. horizontal equity;
4. vertical equity;
5. stability;
6. regulatory neutrality;
7. compatibility with strategic plan.

Administrative feasibility refers to the economics of administration, collection costs and the costs of compliance. A "good" revenue source is administratively simple, with a clearly defined tax base and tax-rate schedule, is enforceable and displays certainty in its application. That is, taxpayers understand its regulations and can predict their tax burden. Compliance costs can take the form of payments to lawyers and accountants, maintenance of special tax departments by large corporations, or use of the taxpayer's own time and effort for keeping records and preparing tax returns. To be *socially and politically acceptable*, a revenue source must be consistent with notions of fair play. The system cannot be considered too onerous when compared with the generalized perception of benefits derived from services. *Horizontal equity* implies that those individuals who are similarly situated (i.e., have the same income) are treated equally. *Vertical equity* is concerned with the "proper" division of the tax burden among people with different abilities to pay. Revenue *stability* for state and local governments may be considered in two different contexts: (1) as a criterion concerning the fluctuations in total income of residents and in involuntary unemployment, induced by changes in tax policies; and (2) in terms of the stability of tax revenues to state and local governments when external changes affect state and local economies. A revenue source is *regulatory neutral* if it has little or no distorting impact on private production and consumption decisions. *Compatibility with strategic plan* requires tax analysts to anticipate the consequences of each tax in their revenue program and with respect to the overall tax structure so that, if a public policy is directed to one goal, a new tax policy is not directed to an opposing goal.

2.3. The tax alternatives

In the current case (detailed below), the following four tax options were identified by those city council officials participating in the study as alternative strategies for generating an additional $1,000,000 in revenue:[1]

2.3.1. Real estate tax

An increase of 1.19 cents is needed. Real estate tax is levied and collected each year on the assessed value of real property. All real estate is assessed at 100% of fair market value. Reassessments are done each year. The current tax rate is $1.445 per $100 assessed value of real estate. Federal, state, and local government properties, and properties belonging to churches or approved not-for-profit organizations are exempt. Also, tax relief is

given to those persons not less than 65 years of age with income not exceeding $17,000 and financial worth not exceeding $75,000. Relief varies from 80% to 11% depending on income and worth. 2816 individuals are expected to participate in this program for eligible relief of approximately $1,300,000. A one time rate increase would require minimal computer program changes. As the rate increases, delinquencies could conceivably increase, causing a greater need for tax enforcement. The primary cost of this would be an increase in personnel and, possibly, costs of litigation.

2.3.2. Personal property tax

An increase of 12.14 cents is needed. Personal property tax is levied and collected on tangible personal property, including boats used for pleasure, mobile homes, automobiles, and furniture and equipment used in business. The current tax rate is $3.70 per $100 assessed value. Automobile values are based on the National Auto Dealers Association average trade-in value. Furniture and equipment is assessed at a depreciated scale based on year of purchase. A onetime rate increase would require minimal computer program changes. Since the value of furniture and fixtures, representing approximately one third of the revenue source here, is assigned by the individual paying the tax, auditing would be required as one component of collection. As delinquencies rise, there would thus be a need for additional audits of businesses within the city.

2.3.3. Local sales tax

An increase of 0.04 cents is needed. The current rate is 4.5 cents per dollar of taxable sales, of which one cent is remitted back to the locality in which the sale occurred. The tax is sent by local businesses to the state department of taxation in the month following the actual sale. The local portion is then sent back to the locality in the following month, thus producing a two month lag between sale and receipt of the tax. A rate increase would require legislative changes, since the city is currently at the cap imposed by the state. An increase may result in delinquencies, and failure to pay by some establishments could result in increased state audits or lost tax dollars. A rate increase would not directly result in higher administrative costs to the locality.

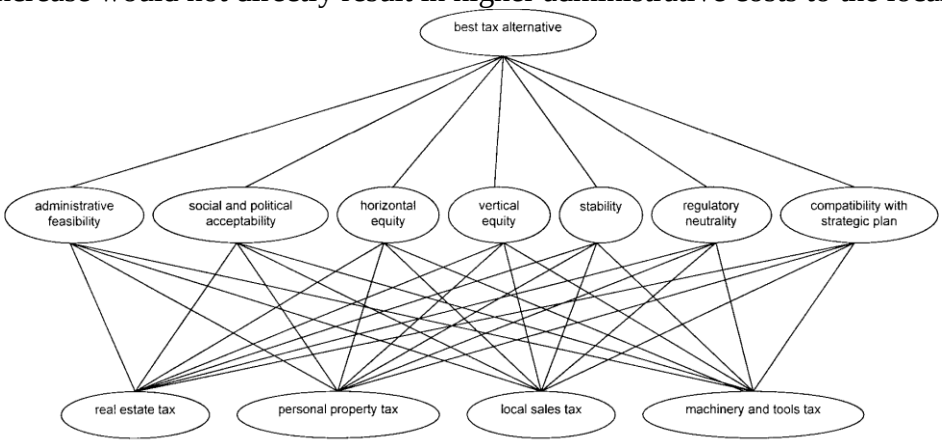

Fig. 2. The city tax model.

2.3.4. Machinery and tools tax

This is a tax imposed on the value of machinery and tools used in manufacturing processes. An increase of 15.84 cents is needed. The current rate is $2.30 per $100 assessed value. The value of machinery and tools is depreciated based on age. Previous year purchases are assessed at 90%, two year old purchases at 80%, three year old purchases at 70%, four year old at 60%, five year old at 50%, six year old at 40%, and idle equipment at 10%. There are currently approximately 400 businesses in the study area that pay the machinery and tools tax. The three largest manufacturers account for 66% of all such payments, with the largest contributing 50% of the total tax collected. Bills are mailed March 1 and the tax is due by May 1. Payments not received by this date are deemed delinquent and are charged a penalty of 10% and interest is accrued at 10% per annum. A rate increase would require minimal computer program changes. The value of machinery and tools is provided by the manufacturing business and thus requires audits on occasion. A rate increase could conceivably encourage delayed payments and thus increase audit costs.

2.4. The conceptual model

Using the seven criteria and four tax options described above, the hierarchy depicted in Fig. 2 can be constructed. To complete this model, importance weights for the seven criteria as well as the impact of each tax alternative on the evaluation criteria must be determined.

2.5. Determining criteria weights

To capture the model and to facilitate determination of the criteria weights, *Expert Choice*, a commercially available package for selecting among multiple alternatives was utilized (Expert Choice Inc., 4922 Ellsworth Avenue, Pittsburgh, Pennsylvania, USA). Expert Choice was chosen because of its good appraisal in a study that compared several multi-attribute decision making packages [20]. Clearly, the criteria weights are reflective of the decision-makers' personal preferences, where, importantly, raising taxes or imposing new taxes are political issues subject to ideological tenets that could potentially affect the decision-makers' careers. The decision-makers in this project were Richmond, VA city council members, who, collectively, have the power to raise or lower taxes, or impose new taxes.

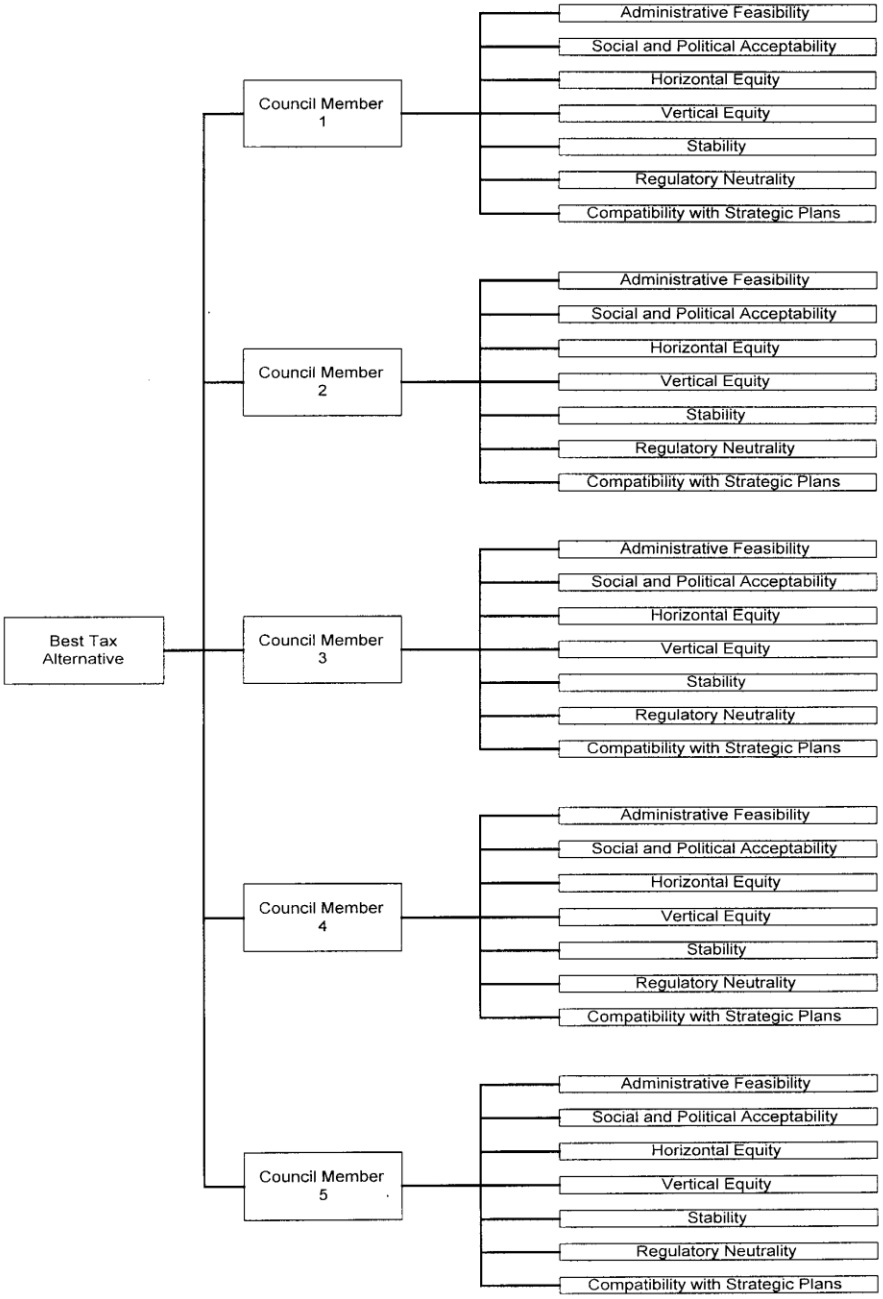

Fig. 3. Hierarchy with multiple decision-makers.

One way to handle multiple decision-makers in AHP and *Expert Choice* is to create an intermediate level in the hierarchy of Fig. 2, between the criteria and the overall goal. This level would consist of the decision-makers, as shown in Fig. 3. Assuming that each city council member (as noted below, five, in the current case) has an equal voice in determining policy, these decision-makers would have equal impact, and, thus, equal weights, with respect to the overall goal. Each decision-maker was thus asked to compare each of the seven decision criteria as to their importance in achieving the best possible tax plan.

Within Expert Choice, this comparison is normally pair-wise, rating one criterion against another as equal, moderately more important, strongly more important, very strongly more important, or extremely strongly more important, corresponding to numerical values of 1, 3, 5, 7, or 9 (or 1, 1/3, 1/5, 1/7, 1/9, if the relation is reversed). Intermediate values are also allowed. The comparison can be done verbally, numerically, or graphically, with preferences indicated by the lengths of bars or the sizes of pie slices.

As noted previously, the project described in this paper was undertaken in the city of Richmond, Virginia, the state capital with more than 200,000 inhabitants. The city council consists of nine members. However, only five participated here (although all nine had initially agreed to do so). Individual appointments were set up at City Hall with the council members, during which the comparisons were carried out using a laptop computer with Expert Choice installed. The council members were allowed to choose between verbal, numerical, or graphical input. Most chose the verbal mode first, but when shown the graphic equivalents, several modified their decisions. Reaction of the participants varied between enthusiastic and somewhat fearful of the technology. The main problem encountered involved last-minute cancellations of appointments, and subsequent unfulfilling trips to City Hall.

2.6. Evaluating the tax alternatives with respect to the criteria

For current purposes, a form of Delphi [21] was used to solicit the ratings of several (eight) tax experts on the four tax alternatives relative to the seven criteria. Of interest here is the Delphi process in combination with AHP, called the *Delphic hierarchy process* (DHP). It was originally proposed by Khorramshahgol and Moustakis [22], and applied to a problem in location planning by Azani and Khorramshahgol [23]. An advantage of using Delphi is that it permits multiple decision-makers to reconsider their responses and thus, possibly, improve their individual decisions. Obviously, there is no guarantee that the decisions will improve in terms of quality, effectiveness, etc. A disadvantage of using Delphi is the extra time required to provide feedback and obtain an additional response.

A DHP-based instrument was created and sent to the tax experts. It asks them to pair-wise compare the four tax alternatives with respect to each of the seven criteria, as shown in the example of Fig. 4 (for the social and political acceptability criterion).

With respect to **social and political acceptability**:

		Reasoning
plan 1 is preferred to plan 2 ___	plan 2 is preferred to plan 1 ___	_____
plan 1 is preferred to plan 3 ___	plan 3 is preferred to plan 1 ___	_____
plan 1 is preferred to plan 4 ___	plan 4 is preferred to plan 1 ___	_____
plan 2 is preferred to plan 3 ___	plan 3 is preferred to plan 2 ___	_____
plan 2 is preferred to plan 4 ___	plan 4 is preferred to plan 2 ___	_____
plan 3 is preferred to plan 4 ___	plan 4 is preferred to plan 3 ___	_____

Fig. 4. Example of survey question.

Respondents were asked to pair-wise compare the four plans and to indicate a preference on a scale of 1 to 9, where 1 indicates indifference, 3 indicates moderate preference, 5 indicates strong preference, 7 indicates very strong preference, and 9 indicates extreme preference. The preference value is to be entered on the line with the corresponding preference statement. (The reverse statement would have no number entered, i.e., there would only be one entry per line.)

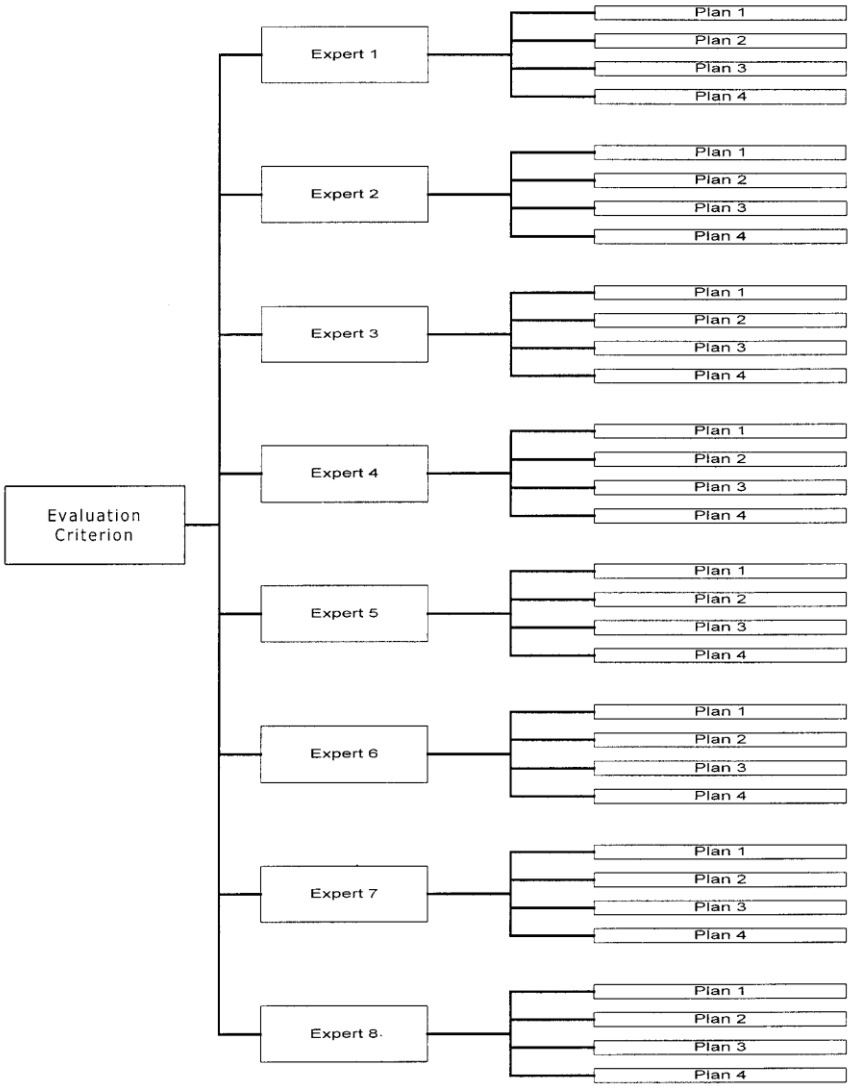

Fig. 5. Hierarchy for evaluating tax plans with respect to each of the evaluation criteria.

In our approach, initial responses were made available anonymously to the tax experts, who were then asked if they wished to revise their original answers. This process would have been repeated if significant divergences remained in the second round results. In our project, 11 tax experts were initially asked to participate, wherein eight responded in the first round. The ratings of all eight, including comments, were summarized and sent back, to see if any respondents wished to change their original ratings. Five of the eight responded in the second round; however, two of the responses were not useable. Because of the low return rate in the second round, the original eight responses were used in determining the impact of each of the four tax plans on each of the seven evaluation criteria. The multiple decision-makers were modeled by inserting an additional level in the hierarchy between the tax alternatives and the criteria. This level consisted of the tax experts with each weighted equally. Fig. 5 shows the Expert Choice model for one of the criteria. Obviously, seven such hierarchies were needed here.

3. Results

Results of the criteria weightings by the five council members are shown in Fig. 6. Note that the members' weights are represented by the corresponding heights of five vertical bars. The divergence in these weightings stems mainly from two council members, each of whom focused on one specific criterion. One member (No. 3) thus saw everything as political and focused on social and political acceptability, while the second (No. 5) felt that compliance with strategic plan was of overwhelming importance.

The final results were entered into the Expert Choice model using the complete hierarchy of Fig. 7. Note that every item in each layer in Fig. 7 is connected to every item in the adjacent layer.

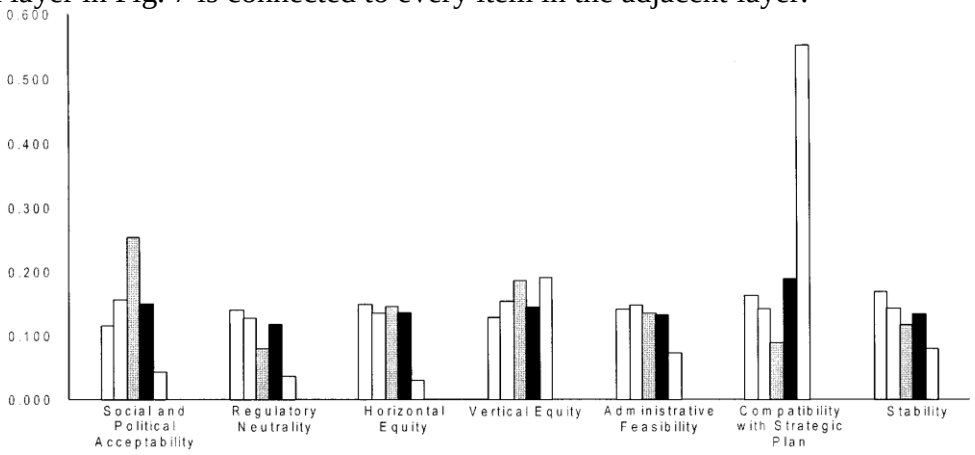

Fig. 6. Criteria weightings. (Note: Each bar represents one of the five participating city council members.)

Fig. 8 shows the final results from the model in Fig. 7, combining the ratings of criteria by the five council members and the ratings of the four tax plans by the eight experts. As can be seen, Plan 3, raising the local sales tax by 0.04 cents, is the highest rated with a weight of 0.365, followed by Plan 1, raising the real estate tax by 1.9 cents, with a weight of 0.293. Both are preferred by a wide margin to the other two plans, i.e., raising the machinery and tools tax by 15.84 cents, and raising the personal property tax by 12.14 cents, which achieved weights of 0.197 and 0.145, respectively. Expert Choice also automatically calculates an inconsistency index, based on the consistency or inconsistency of all the pair-wise comparisons made. An inconsistency index below 0.1 is generally considered acceptable. As shown in Fig. 8, the inconsistency index in our study was 0.07, and thus well within the acceptable range.

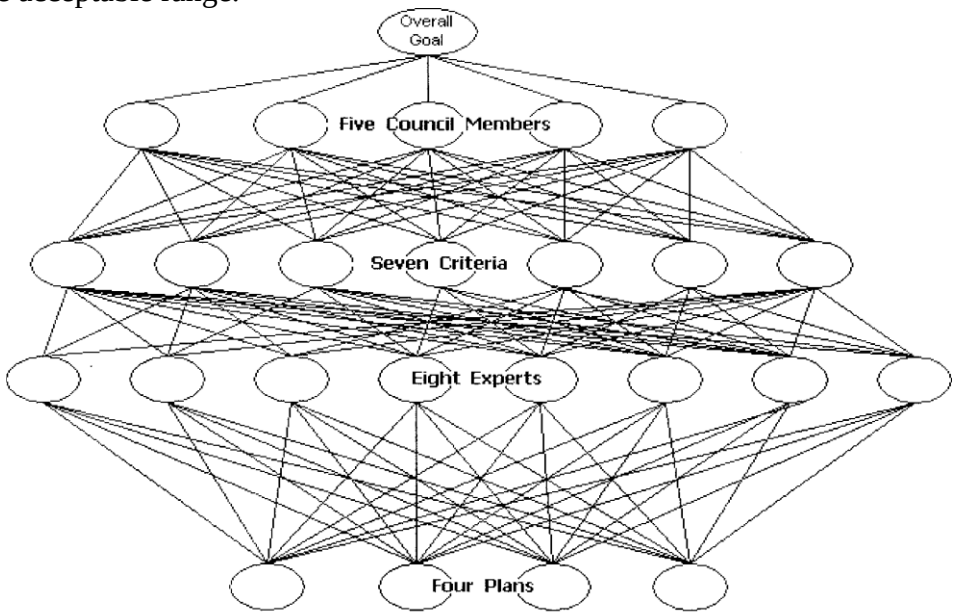

Fig. 7. The complete hierarchy.

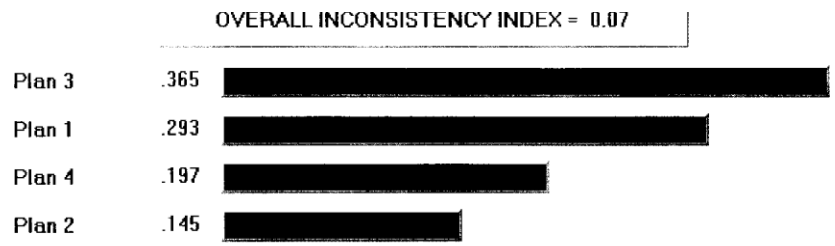

Fig. 8. Final weights of the four tax plans with respect to the overall goal.

Using the expert ratings of the three useable responses from the second round in our model reversed the preferences for Plans 3 and 1. Plan 1 thus became the first choice, though by a very narrow margin (a weight of 0.385 for Plan 1 vs a weight of 0.381 for Plan 3). Such small differences cannot be considered significant; one could thus say that Plans 1 and 3 are preferred equally. The preferences for Plans 2 and 4 were also reversed, yielding weights of 0.131 for Plan 2 and 0.102 for Plan 4. The inconsistency index was again 0.07. Although the response rate of three from the original eight experts is too low to be used with confidence, it does seem to strengthen the earlier result that Plans 1 and 3 are preferred to Plans 2 and 4.

4. Conclusion

The current paper presents a novel approach to evaluating tax alternatives, given the need to generate a certain amount of revenue. In spite of various difficulties encountered in completing this project, the authors feel that their experience in constructing the model and the results based on ratings by local decision-makers and tax experts show this to indeed be a feasible approach to tax planning.

AHP lends itself as a suitable methodology for capturing the relative importances local government officials place on various decision criteria. Our experience has shown that local politicians, with the help of consultants, can be sufficiently confident in using tools such as AHP-based Expert Choice. Although some subjects were reluctant at first, their confidence rose with time. One of the problems encountered here involved participation of city councilors. This was not due to their objection to the methodology, but, rather, to difficulties in scheduling. We suggest that as local government officials become more appreciative of the value of such methodologies, they are likely to become more involved in the application process.

One valuable feature of AHP is its allowance for multiple decision-makers, wherein individual opinions are integrated into a single outcome. Decisions by government bodies such as city councils can thus be facilitated. In this regard, the model allows a decision-maker to compare his or her personal decision outcome to that of the group. Although a decision may still be reached by majority vote, each group-member is thus able to observe general trends within the group before casting his or her vote.

The ability of AHP to combine multiple decision-makers' responses also allows for the integration of predictions by multiple experts into a single rating of alternatives, relative to specified criteria. Using an iterative approach that provides intermediate feedback, such as Delphi, may help in smoothing the outcome further. In this way, the final result may not be the average of very differing personal opinions, but, rather, a true consensus conclusion. Again, the major difficulties encountered by the authors were less objections in principle, than motivation of the participants to respond in a timely fashion. An iterative approach can also serve as a mediation process when dealing with a group of decision-makers, such as a city council. We are aware, of course, that such an approach would likely exacerbate the previously encountered scheduling problems.

An additional problem that may be encountered when dealing with elected bodies is the changing of their composition over time. A simple yet important lesson learned here is that when dealing with such groups, the timing of a project must be attuned to members' terms of office.

Notes:

[1] As noted below, the city here is Richmond, Virginia.

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