Expert Panel Method of Forecasting Land Use Impacts of Highway Projects

PATRICIA M. MULLIGAN and ALAN J. HOROWITZ

ABSTRACT

The validity of expert panel forecasts of land use impacts of highway projects in small urban areas was evaluated. A panel was assembled consisting of individuals with backgrounds in different aspects of land use and forecasting. This panel of experts was asked to predict the changes that have occurred over the past 20 years from a 1965 perspective. The panel received information on each of the two case study cities, as well as brief descriptions of the projects. The forecasting instrument consisted of a map for each city and a questionnaire to elicit evaluations of 31 features of community development. Each feature was rated as to whether an impact would occur, whether the impact was negative or positive, and the magnitude of the impact and its importance. On the map the panelists predicted the areas in which residential, retail, service, and industrial impact would occur. The first round of this study was conducted in person and the second round was completed by mail. After the results from the second round were tabulated, they were submitted to a smaller panel in each of the cities for evaluation with respect to accuracy and usefulness.

A potentially important impact of any highway project is its effect on the spatial distribution of urban development. This type of impact is often referred to as a secondary land use impact in order to distinguish it from changes in land use that occur within the right-of-way. Secondary land use impacts are not direct consequences of the project, but result from modifications in access to parcels of land and from modifications in travel time between various points in the urban area. Secondary land use impacts have included regional shopping center developments, urban sprawl, and economic decline of central business districts. The reasons that highway projects cause impacts on land use have been well understood for at least 2 decades (1). However, existing techniques for assessing land use impacts are directed toward large freeway and rail transit systems in major urban areas. Little effort has been devoted to formulating techniques that could be used for assessing impacts of highway projects in or near small communities--the type of project that is now most often built.

The overall purpose of this study was to determine the applicability of existing techniques for assessing highway-related impacts in small communities. Existing techniques were categorized as (a) assessment by experts such as an expert panel or gaming simulation; (b) computer simulation; (c) statistical models; or (d) qualitative assessment such as a series of short questions, a checklist, or a cross-impact matrix. A representative technique was selected from each category.

The four selected techniques were evaluated by applying them to one or more case study projects in Wisconsin. The projects were completed between 10 and 20 years ago--long enough so that any changes in the development pattern of the urban area would be readily apparent. As best as possible, the techniques were applied as they would have been at the time of the projects.

Two types of validation were sought: (a) the forecasts from the techniques should correspond to actual patterns of development since the project was built, and (b) the techniques should not require more effort than would be justified by the quality and usefulness of the results.

One of the techniques examined and evaluated for usefulness in predicting secondary land use impacts of highways was an expert panel. This technique provides a contrast to other methods investigated in this overall study. An expert panel can handle intangible impacts, such as aesthetics, strength of government authority and attitudes of financial institutions, and extremely localized impacts, such as the development of a regional shopping center. These impacts are not easily assessed by mathematical models. In addition, an expert panel evaluation can assess intangible impacts with more comprehensive insight than can be accomplished with simple checklists. A structured expert panel appeared to have the following desirable characteristics: (a) expert knowledge and experienced intuition, (b) time efficiency, and (c) low cost.

PROMINENT METHODS OF EXPERT PANEL EVALUATION

Expert panel techniques include focus groups, gaming simulations, and structured expert panels. These have received considerable attention, both in the literature and in practice, because they are able to handle issues that are not easily quantifiable. It has been shown that human judgments based on these methods can enhance the process of land use forecasting.

Focus groups (2) allow a small number of participants (typically 6 to 10) to discuss a particular issue in an unstructured manner under the guidance of a skilled moderator. The early discussion is intended to be quite broad so that the participants will be more comfortable while interacting. Through

Center for Urban Transportation Studies, University of Wisconsin-Milwaukee, P.O.Box 784, Milwaukee, Wis. 53201.

interaction more spontaneous and possibly more honest comments will be made. When the group is assembled it is necessary to allow for diversity as well as similarity. If too much contrast is present it may stifle discussion. The expertise of the moderator is the essential element in a successful group. It is the responsibility of this individual to maintain the direction of the group on the subject under consideration. This task requires a high level of skill. Clear, unambiguous interpretation of the results is rarely possible because of the role of the moderator and the unstructured nature of this type of research. This technique would be useful at an exploratory stage but would not be suitable for detailed land use forecasting.

Simulations are simplified representations of larger, more complex systems. Three different types can be identified: (a) those that use computers exclusively (known as models), (b) those that use a combination of computer and human players, and (c) those that use only human players. Those simulations that use only humans to generate operations and calculate consequences are known as gaming simulations (3).

Games have three features: (a) explicit rules about how a goal is to be achieved with certain resources, (b) players' psychological orientation that the goal is valueless in itself, and (c) social consensus that the activity is inconsequential for the serious business of life (4). When games are used by decision makers in the real world, the third feature is naturally violated. A particularly representative game, which was influential in the development of the expert panel procedure that was evaluated in this paper, is the Community Land Uses Game (CLUG).

CLUG (5) attempts to predict how land will be used based on existing constraints. The players' objectives in this gaming simulation are to buy and sell land, to construct commercial and residential property, to put industries into operation, and to make a profit. CLUG most resembles a board game, complete with dice, markers, and play money. It is able to stimulate the interactive elements of conflict and cooperation, as well as strategic thinking. CLUG is designed to include 9 to 25 players who participate in 5 to 10 rounds of the basic game, plus additional experiments if appropriate. The game could easily occupy 20 hr or more of playing time. In this game there are some preestablished components, some left to chance (the roll of the dice), and others are open to negotiations and decision making.

Because of its simplicity, CLUG will not predict what will take place in the future, but will provide an arena for creating possible outcomes. Modifications can be made to better simulate different problems. An argument that can be posited against games such as CLUG is that results will be constrained and directed by the game's design. This is not necessarily undesirable if the limitation of the framework is clearly understood. CLUG can be valuable, but its chief virtue lies in education rather than prediction. Students of urban affairs or urban planning may be better able to anticipate real-world problems after playing CLUG.

One of the most familiar expert panel forecasting techniques is the Delphi method. The Delphi method (6) attempts to reach consensus through an iterative process. Delphi panels were first used to predict when events would take place. Rand Corporation has conducted several Delphi panels (7). Some of the areas investigated included scientific breakthroughs, automation, space programs, and future weapons systems.

For Delphi to attain the most reliable consensus of opinion held by a group of experts, intensive questionnaires with controlled feedback are used. After one round has been completed, the findings are tabulated and returned to the panelists. The panel-monitoring team may choose to provide this information verbally or may use a statistical technique to represent central tendency. Equipped with this additional information, participants may modify their original responses. The number of rounds is not prescribed, but generally three rounds are needed to gain consensus and show stability.

Delphi employs the services of several experts but interaction between them is discouraged. One of the most important features is that the panelists are unknown to each other. Anonymity is preserved by administering the questionnaire through the mail. With Delphi, a dominant personality or an individual with a particularly prestigious title would be unable to exert pressure, either consciously or unconsciously, on the other participating individuals.

The Delphi panel should consist of experts with varied backgrounds. In this way the forecast will benefit from the diversity of knowledgeable input. These experts are often individuals with many commitments; therefore, it is imperative to explain the expected amount of time that needs to be devoted to this activity. The time needed is not extraordinarily large, but individuals with full schedules need to be informed of the requirements.

Ervin (8) applied the Delphi method to regional industrial land use forecasting in Tennessee in the mid-1970s. This study was considered an abbreviated version, according to the author because only two rounds were conducted and no effort was made to arrive at a stabilized consensus of opinion. However, it did provide useful information. Because this set of panels was conducted for several industries, it was discovered that the relative importance of the various factors would vary from one industry to another and location factors were important to some industries but of little significance to others.

More recently Cavalli-Sforza and Ortolano (9) attempted to predict impacts of three alternative transportation projects in San Jose, California, by using the Delphi method. The impacted area was divided into four zones, and panelists made separate predictions for each zone. Regarding land use, specific forecasts were made with respect to expected population, number of single-family units and multifamily units, and number of commercial and industrial employees for 2 future years. The panelists were also provided this information for 1970 and 1975 so that they would have knowledge of existing trends. As the rounds progressed there was evidence of ranges tightening around the median responses.

The greatest difficulty experienced by Cavalli-Sforza and Ortolano was the amount of time needed to reach a successful conclusion. It took progressively greater periods of time to recover the questionnaires as the rounds advanced. The third round was completed 18 months after the inception of the study. Monetary compensation is one means of counteracting the problem. Of course, the most desirable solution is to bring together a totally committed panel from the beginning.

Cavalli-Sforza and Ortolano (9) were only able to conclude that the Delphi method functioned as expected. Because they had actually performed a forecast into the future, it was not possible to evaluate whether the results were reasonably accurate.

STUDY TECHNIQUE: STRUCTURED EXPERT PANEL

For this study it was desirable to combine several positive aspects of the techniques mentioned earlier.

An iterative questionnaire, like the Delphi method, formed the basis for the overall structure. However, it was believed that the technique would benefit from the informal setting, the personal input, the immediate feedback, and the guidance of a moderator, which are essential to focus groups. because land use is a spatial issue, the structured expert panel would also benefit from a map, like the one in CLUG. By drawing on these earlier methods, it was possible to develop a technique that could handle the full range of land use impacts.

Panelists were asked to rate the following 31 features of community development that could change because of a highway project:

- Employment in existing industrial park (manufacturing);
- Industrial employment elsewhere within the study area;
- Employment in regional shopping centers;
- Employment in community shopping centers;
- Employment in neighborhood shopping centers;
- Retail employment in the central business district (CBD);
- Employment in hotel and motel services;
- Employment in repair and cleaning services;
- Employment in advertising, management, consulting and legal services;
- Amount of regional post-secondary educational facilities (colleges and technical);
- Amount of local schools;
- Amount of regional health care facilities;
- Amount of local health care facilities;
- Service employment in the CBD;
- Employment in restaurant and fast food establishments;
- Total population;
- Amount of unoccupied housing units;
- Ability of local government to control land use through traditional measures (zoning);
- Length of average trip to work in miles;
- Amount of ridesharing;
- Amount of intercity travel for work purposes;
- Overall congestion in the study area;
- Congestion in the area of highway project;
- Aesthetics of area surrounding the highway project;
- Amount of development in communities near but not part of the study area;
- Amount of development in areas with incomplete utility service;
- Willingness of financial institutions to lend money for further land development;
- Land values near project (within 1,000 ft);
- Land values in the remainder of the study area;
- Tax base; and
- Utilization of existing parks.

The questionnaire was based on a modification of the Leopold technique (10), which asks respondents to rate both the magnitude and importance of an impact. Both ratings used category scales with 0 signifying no importance or no impact, and 10 signifying extremely important or extremely large impact. An example set of scales is shown in Figure 1. Panelists were also asked to record the direction of the impact (larger or smaller). Panelists were specifically not asked questions regarding the desirability of the impact. When no impact was recorded, panel members were told to explain this response.

In addition, maps were provided for each of the case study cities, Sheboygan and Wisconsin Rapids, so the locations of residential, commercial, industrial and service impact could be identified. These maps represent the cities as they existed in 1965 (Figures 2 and 3). The existing major road networks are featured together with proposed changes defined by a heavy dashed line and areas categorized as industrial, commercial, residential, open space, or park, and by the concentration of workers. The levels of soil suitability for septic tanks were defined. Also included were the locations of water and sewage plants, as well as schools, hospitals, and shopping centers. The maps were not divided into zones. Color pencils were provided for panelists to designate areas where significant changes in land use activity would occur. In addition, panelists were asked to show where a regional shopping center or a concentration of services might develop.

Because this study "predicted" events that have already occurred, it was necessary to choose individuals that had little familiarity with the case study cities. The prospective panelists were asked to rate their familiarity with six cities (including the two case study cities, and based on responses some otherwise highly qualified individuals had to be eliminated. A 13-member panel was recruited consisting of five experts in technical aspects of highway planning from the Wisconsin Department of Transportation (WisDOT), four university professors who specialize in community development, three community planners from separate agencies, and one real estate developer.

The panelists were provided a brief description of each city labeled only as City A and City B. The

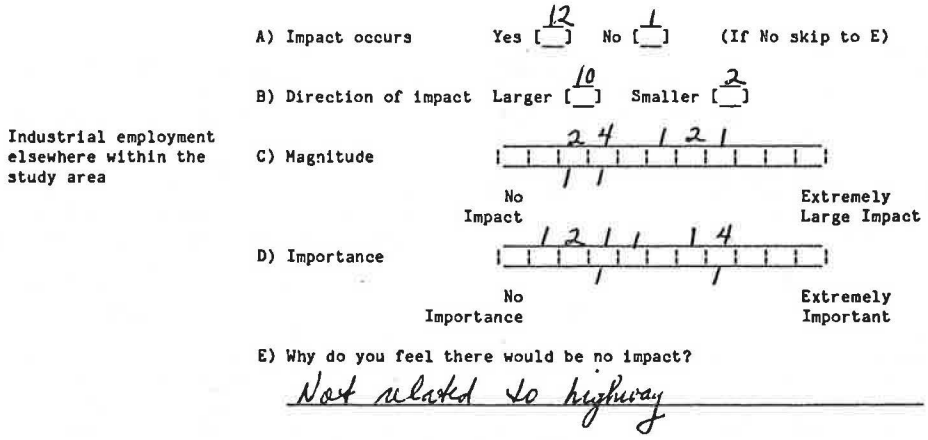

FIGURE 1 Example community feature with scales and first round summary.

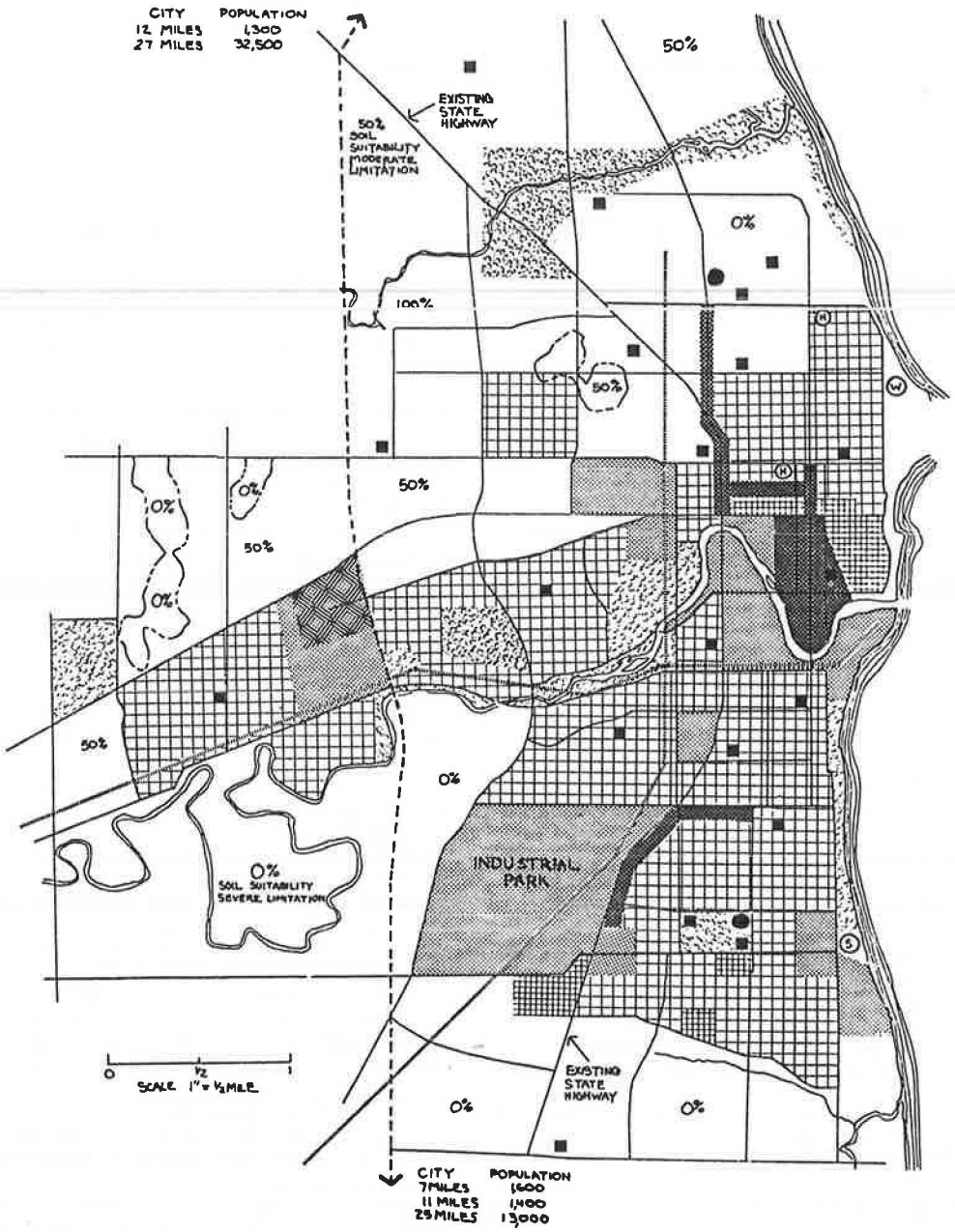

FIGURE 2 Expert panel's base map of Sheboygan.

descriptions contained information regarding size, government, economy, and concentration of employment. The project for Sheboygan was a freeway bypass, just west of the central city. The project for Wisconsin Rapids consisted of two events: (a) widening portions of an existing two-lane rural highway that is a major link in the state highway system, and (b) adding a bridge across the Wisconsin River so that traffic on this highway could bypass the CBD.

In the interest of expediting the first round, three sessions were held. Based on the location of panel members, one session took place in Madison, another group met in Milwaukee, and one individual completed the questionnaire for Round 1 in his Milwaukee office. The sessions were accomplished on three consecutive working days. Panelists were read a narrative of societal conditions in 1965 and given complete instructions for handling the features of the community development questionnaire and the map. A member of the study team was present to answer any questions, but the panelists were reminded not to interact. It was necessary to provide some clarification at each session, but the panelists were able to make their responses expeditiously.

Round 1 summarized responses for Round 2. The responses for Questions A, B, C, and D for each feature were tallied on a questionnaire as indicated in Figure 1. If the panelist believed that the community feature would be larger as a result of the project, the magnitude or degree of importance was recorded above the appropriate box on the questionnaire. On the other hand, if the community feature was judged to be smaller as a result of the project, it was recorded below the box. The reasons for no impact, given in response to Question E, were also recorded as shown in Figure 1. It was also necessary to provide a short addendum to the description of each city in response to questions raised by panelists at the time of the first round.

Composite maps for each land use activity (resi-

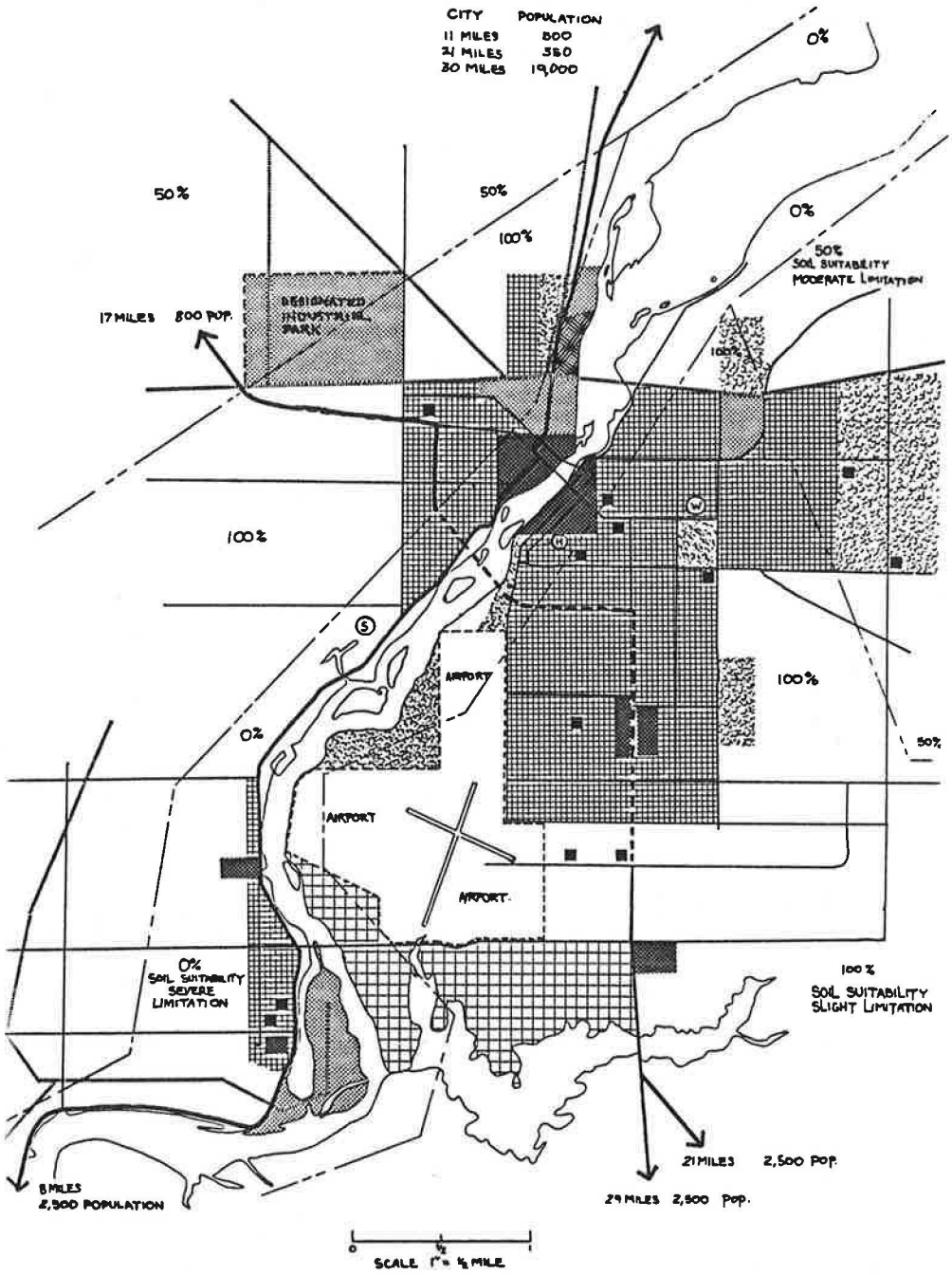

FIGURE 3 Expert panel's base map of Wisconsin Rapids.

dential, retail, service, and industrial) were developed from the information provided by Round 1. In the first round, panelists had one map on which they were to define the areas of impact for the different land use activities. In the second round, four maps were provided for each city, one for each activity, showing how all the panelists evaluated the areas of impact.

The second round, unlike the first, was conducted by mail. All the summaries compiled from Round 1 were mailed approximately 2 weeks after it took place. The following materials were provided for each city: general instructions; a features questionnaire with responses recorded; four maps showing the locations of impact on population, industry, retail, service (not retail); the original description of the city; and an addendum to the description with information requested by the panelists in the first round. The addendum for Sheboygan included a map showing planned interchanges.

In Round 2 panelists were asked to respond to exactly the same questions as they had previously answered. This gave them an opportunity to reevaluate their answers given the collective responses of the whole panel. Each of the maps now provided zones that could be selected as areas of impact. Panelists again used the color pencils to designate where impacts would occur. However, they were asked to show areas of positive impact in one color and areas of negative impact in another color.

In Round 2 the features of community development responses were tabulated in the same way as they had been in Round 1. Combined results of the map portion were produced by coloring zones to represent the number of panelists that said an impact would occur. Separate colors were chosen for: three to seven

panelists indicating a positive impact would occur in a zone, more than seven panelists indicating a positive impact would occur in a zone, three to seven panelists indicating a negative impact would occur in a zone, and more than seven panelists indicating a negative impact would occur in a zone. The results in Round 2 displayed greater convergence and consensus than in Round 1, especially for Wisconsin Rapids.

EVALUATION OF THE FORECASTS

Because the panelists forecasted events that had already taken place, it was possible to evaluate the accuracy and usefulness of the technique. The results were presented to evaluation panels of local experts for review. These people had actually observed the changes that took place, and, therefore, were in the best position to assess the forecasts.

Separate evaluation panels were recruited for Wisconsin Rapids and Sheboygan. Each panel was made up of four individuals who were active in city planning or highway engineering. All evaluation panel members had lived in their respective cities for at least 20 years and were well aware of the impacts that their city had experienced. The evaluation panels were conducted according to the focus group technique.

The Wisconsin Rapids evaluation panel found the forecasting panel to be most accurate in predicting service and industrial impacts. Both the forecasting and evaluation panels agreed on the location of retail impacts, but the evaluation panel rated the magnitude and importance of retail impacts higher than the forecasting panel.

Overall, there was agreement about population impacts. However, some disagreements about population impacts occurred because the study team did not provide complete enough information to the forecasting panel; neither the maps nor the narrative provided any information about high water tables present in some potential growth areas. Also, the study team did not inform the forecasting panel about a large parcel of open land held by a local high school, which meant that the land was not available for residential development.

In Sheboygan the forecasting panel did not produce as strong a consensus as they had for Wisconsin Rapids. This made it more difficult to evaluate, but the Sheboygan evaluation panel agreed with most of the forecast. The closest agreement concerned the location of industrial activity. The forecasting panel was able to predict the development of a regional shopping center and to pinpoint its exact location. With only a few exceptions, there was agreement on the magnitude and importance of the 31 community features.

The evaluation panel in Sheboygan differed from the forecasting panel primarily on the map portion of the study. The location of retail (excluding the regional shopping center), service, and residential areas was only partially accurate. Again, the errors were traced to insufficient information being given to the forecasting panel. For example, access to areas near freeway interchanges was not fully described. The evaluation panel disagreed with the forecasted level of employment in community and neighborhood shopping centers and in some services. As in Wisconsin Rapids, the Sheboygan evaluation panel felt that the magnitude and importance of negative impact on retail in the CBD were stronger than forecasted.

Overall, the forecasting panel slightly underestimated the impacts in Wisconsin Rapids and slightly overestimated them in Sheboygan. Inaccuracies resulted chiefly from incomplete information. This does not indicate a serious flaw in the procedure. In this study it was necessary to reconstruct data from a much earlier year to be presented to a group of people who were unfamiliar with the cities. But when such an approach is implemented for a future project, the forecasting panel can and should include residents who would be much more informed about current conditions.

Both evaluation panels believed that the format of presenting maps and features of community development was useful. They had little trouble in understanding the forecasts, but tended to confuse measures of consensus as being measures of strength.

DISCUSSION AND CONCLUSIONS

A forecast using a structured expert panel can be conducted quickly and efficiently, and provides insights that only human expertise can supply. This study was completed in less than 2 months, once the instrument was developed. A structured expert panel is also a relatively inexpensive undertaking. Participants do not require sizable monetary compensation, and there is no costly equipment. A wide range of issues (including intangible ones), can be addressed. A strong consensus can be reached on difficult subjects; consequently, the results can be interpreted as more dependable than those of a single expert.

According to the evaluation panels, the forecasts were reasonably accurate and a good measure of agreement was present. Where the forecasts diverged from actuality, the divergence could usually be attributed to inadequate information presented to the panel. This problem could easily be avoided in actual practice because both more detail and respondents with greater knowledge of a particular city would be available. An ideal panel would consist of both local residents and outside experts. In addition, a limited amount of data could be collected between rounds if a strong need is indicated by the panelists.

The multiple-round format gave the panel a chance to request additional information, ask for clarification of information already provided, and to define their own zones for reporting impacts. In essence, the panel further refined the evaluation instrument as they completed the first round. A dynamic instrument is an important feature. It permits the panel to raise and evaluate issues that may have been overlooked by the study team and to discard issues it deems irrelevant.

It has been demonstrated that panelists are able to fully understand the development processes in cities the size of Sheboygan and Wisconsin Rapids. For small cities only a limited amount of information needs to be presented. Clearly, a panel could be overloaded with data when evaluating impacts in larger cities. However, it was not possible to determine from this study the maximum-sized city that could be evaluated with a structured expert panel.

It would have been possible to ask the expert panel to make projections for a future year (2010) but it would not have been possible to assess the accuracy of an expert panel for forecasting land use impacts. By projecting the present from 1965, accuracy could be tested. The experts did benefit from their own observations of other small cities over the previous 20 years. However, it is difficult to judge whether this knowledge unfairly strengthened the results of this study. Overall, this method of forecasting the present worked well and is recommended to others seeking to test forecasting techniques.

The first round of this study was conducted in group sessions to expedite the process. It would have been possible to conduct the entire procedure by mail, but long time delays would have resulted. The excessive time required to complete the San Jose study was considered problematical. If highway planners were to use this technique, such a time line would negate the usefulness of the findings. Although anonymity was violated by conducting the first round in group sessions, panelists were instructed not to discuss their opinions with other panelists. There was no evidence that this method of conducting Round 1 biased the results.

Traditionally, land use forecasting is done with a mathematical model. It is not the purpose of this paper to present an evaluation of that type of forecast. However, a Lowry-Garin model was used to forecast the impacts of the same project in Wisconsin Rapids. Results of the two methods can only be roughly compared. It was found that the expert panel produced a forecast that was very similar to that of the Lowry-Garin model, both in terms of size and location of impacts. Generally, the expert panel produced results with more texture but with less quantification.

Even though the results of an expert panel forecast are not quantifiable in the same manner as those produced by a mathematical model, they are not necessarily less reliable. Exposure to a vast array of sophisticated, computer-assisted techniques has created a natural tendency to rate these as most accurate. But a structured expert panel benefits from personal insight that would be difficult to incorporate into a mathematical model.

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