Economic Insights into the Siting Problem: An Application of the Expected Utility Model

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Despite the generally recognized need for facilities such as power plants, landfills, prisons, and medical laboratories, finding host sites has become extremely difficult. This study uses the expected utility (EU) model to explain individuals' preferences in the hypothetical case of siting a municipal solid waste composting facility. The three principal factors which EU theory prescribes would affect the decision process—benefits of the proposed facility, losses from the facility, and the (perceived) probability of various scenarios occurring—embodied by the variables in a multinomial logit model explain a substantial amount of the variation in siting decisions.

Despite the generally recognized need for facilities such as power plants, landfills, prisons, and medical laboratories, finding host sites has become extremely difficult. A National Science Foundation report stated that "the greatest single obstacle to proper land disposal [of solid waste] is citizen resistance to sanitary landfill sites." More generally, Popper (p. 257) noted that". . .siting controversial facilities of all sizes and kinds has become increasingly difficult. It has emerged as a significant national policy problem." Such local behavior is typical of what has been called the "NIMBY" or not-in-my-backyard syndrome. It is generally thought that NIMBY-opposition to facility siting comes from people in close proximity to the facility who bear high (real or perceived) costs while the facility's benefits accrue to a larger outside population (Raiffa; Hadden and Hazelton).

The problem of siting waste management facilities is of concern to rural as well as urban communities. In addition to disposing of their own waste, rural communities have increasingly been the receptor of urban waste since they tend to be poorer and less densely settled (Bailey; Bealer et al.). Bacot, Bowen, and Fitzgerald found that respondents to a Tennessee survey note solid waste as a much more serious problem than water or air pollution, yet 70% of those surveyed would oppose a landfill sited within five miles of their home. Because facilities are unwanted and because industry tends to take the path of least resistance, communities with little political/economic clout are often targeted for such facilities, leading to charges of "environmental racism" (Bullard; Jaffe), although some of the studies which have concluded that this type of racism is an issue may have lacked "sufficient rigor to affirmatively establish evidence of discrimination based on race" (Kriesel and Centner, pg. 2). In any case, the presence of external costs without any compensation contributes to anti-facility, NIMBY sentiment and inequities.

Local public opposition to waste facility siting can have several adverse consequences. First, it may delay siting of the facility, necessitating higher waste disposal costs in the interim. Second, short term disposal methods may result in greater health risks to the local public than proper disposal. Third, the capital costs of delay may be substantial, in terms of additional interest payments or increased facility cost (Morrell and Magorian; O'Hare et al.). If local opposition should succeed in blocking construction at the preferred site, a shortage of disposal capacity or siting at a physically or locationally sub-optimal site could occur.

While there have been a number of studies examining what compensation mechanisms or "bidding games" might affect NIMBY behavior (for example, O'Hare et al.; Swallow et al.; Kunreuther and Easterling), there have been fewer efforts to

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ascertain just what motivates different segments of the public. Clearly, the siting issue crosses many disciplinary boundaries—sociology, anthropology, psychology, and others—but economists unquestionably can provide valuable input to the debate. Drawing upon expected utility theory, this article constructs a framework for analyzing what factors influence members of the public to accept or reject a controversial facility, then uses a case study of the siting of a municipal solid waste (MSW) composting facility to isolate and examine policy relevant variables. While findings regarding MSW composting facilities may not generalize to other "problem" facilities, the results provide useful information for understanding the siting problem.

The Expected Utility Model

This study uses the expected utility (EU) model (Schoemaker) as a starting point to explain individuals' preferences for facility siting. Other research has used EU theory to model risk-related issues with a varying degrees of success (see for example Kunreuther et al.; Brookshire et al.; Friedman and Savage). The work by Kunreuther et al. shows that risk perception models may predict outcomes better than the EU model when catastrophic impacts are possible. However, it was felt that MSW composting does not pose the same risks as a high-level nuclear hazardous waste facility.

Adapting the approach of Brookshire et al., if it can be assumed that the principal concerns of local citizens over siting a waste management facility involve changes in property values, environmental degradation, and community character (focus group and survey results confirm that this is indeed the case), the following simplified model can be specified:

$$(1)\qquad EU = \Theta U[V(a) - p(a) - c] + (1 - \Theta)[V(a) - p(a)]$$

where

EU = expected utility with the presence of MSW composting facility

$V(a)$ = "wealth equivalent" of consumer

Θ = probability of negative event occurring

$p(a)$ = cost function, where a is a vector of community characteristics which might include school quality, environmental quality, individual housing characteristics, economic activity, accessibility, crime rate, etc.[1] Thus the facility may have a positive impact on the a vector through, for example, increased tax revenues which improve school quality or a lowercrime rate due to higher area employment.

c = monetary loss which the consumer believes would be sustained if the "worst case scenario" (perhaps ground water contamination from the facility) occurred. The c value also enters the cost function $p(\bullet)$, since living in proximity to a waste facility introduces the risk of having to deal with environmental problems, which is a sort of negative neighborhood characteristic.

This model assumes that there are only two possibilities: the composting facility is sited and operated with no adverse consequences, or a single possible adverse environmental event (e.g. ground water contamination) occurs.

The optimum choice of community or household characteristics a and enviromental considerations c is found using the following first order conditions:

$$(2)\quad a_i : \Theta U'_{gw}(V_i - p_i) + (1 - \Theta)U'(V_i - p_i) = 0 \text{ for all } i$$

$$(3)\qquad c: -\frac{(1-\Theta)p_c}{\Theta(1+p_c)} = \frac{U''_{gw}}{U'}$$

Subscripts on V and p denote partial derivatives and the gw subscript on U represents evaluation in the worst case scenario (ground water contamination). Equation (2) implies that each attribute is chosen at the point where its marginal cost is equal to its marginal value to the consumer, while equation (3) implies that at the optimum the ratio of marginal utilities in the contamination-no contamination states must equal the ratio of the "prices" of the environmental characteristic weighted by (perceived) probabilities of the event occurring.

Using this framework, it can be seen that an increase in perceived damages from a composting facility ($\delta U/\delta c > 0$) would tend to decrease expected utility. Previous research has shown that residents are particularly concerned over possible decreases in property value and contamination of ground water; an increase in the estimated dollar value of damage which could occur (exclusive of probabilities) would be consistent with an increase in c. Hosting a regional composting facility could also be expected to increase local tax revenues, reduce property taxes, and produce jobs, all of which would improve the community and neighborhood characteristics. This increase in expected benefits would presumably increase values in the a vector and would increase expected utility ($\delta U/\delta a > 0$). Finally, a decrease in Θ would improve an individual's expected utility by lessening the chance of a "catastrophic" event. Satisfaction of the conditions in equations (2) and (3) is consistent with either risk aversion or risk neutrality (assuming second order conditions are met).

This situation would be compared by the respondent to the expected utility of the status quo, in which no composting facility is sited. The individual would then avoid all risks involved with the facility, but at the cost of foregoing all potential economic benefits.

In reality, the facility does not pose only the possibilities of a catastrophic event or no problems whatsoever. A more realistic scenario would have a continuum of outcomes which combined economic benefits and environmental outcomes:

$$(4) \qquad V = \sum_{j=1}^{n} \Theta_j U[V(a_j) - p(a_j, c_j) - c_j]$$

and

$$\sum_{j=1}^{n} \Theta_j = 1$$

where Θ_j is the perceived (subjective) probability of event j occurring, and n is the number of possible outcomes. Facility-related examples of c include threats to health and safety, risks to children, and increased traffic, while examples of a would include new jobs, lower property taxes, and economic growth. The EU model posits that an individual's willingness to accept a facility will vary as a function of the perceived negative impact of the facility and its perceived economic opportunities (in the a vector). Thus, as potential losses decrease or potential gains increase, more individuals should find the facility an attractive option.

Policy makers or those seeking to improve the chances of successful facility siting thus have three "targets" to concentrate on when working in the siting area: first, attempt to minimize c; second, attempt to maximize those characteristics in the a vector corresponding to positive developments stemming from the facility; and finally, work to minimize the probability of adverse events occurring and insure that perceived probabilities are close to actual probabilities.[2]

The issue of perceived probabilities is especially important in the solid waste management arena. One of the strongest predictors of attitudes toward an unwanted facility is the perception of risk (Sundstrom et al.; Bacot, Bowen, and Fitzgerald). Kline et al. found that probabilities perceived by an individual should be used instead of actual probabilities predicted by "experts" for a more realistic assessment of a situation, even if the perceived probabilities are far greater than the actual probabilities. However, the consequences of the perceived probability may not be the same as the actual probability and could lead to the "wrong" (or in any case, different) decision. Any behavioral model chosen to evaluate the siting issue should allow for perceived probabilities.[3]

Attitudes vs. Actions: Can Surveys Predict Behavior?

Attitude data used to construct the aforementioned expected utility model were gathered via mail survey. There has been some question when using surveys to gauge public opinion and response, whether what people say has any bearing on what they actually do; that is, the relationship between attitudes and behavior (Azjen and Fishbein; Albrecht and Thompson; Collins et al.; Neill et al.; Sagoff). It is beyond the scope of this study to determine how strongly the attitudes expressed influence later actions. However, recent surveys of community residents in areas where MSW composting facilities had been successfully sited exhibited perceptions of the operating facility's environmental and economic impacts which were very similar to those of the survey used in this study, which tends to lend some credence to these results (Halstead, Walker, and Conway).[4]

The Case Study

To apply the model specified in the preceding section, the issue of siting a hypothetical municipal solid waste composting facility was used. MSW composting is a method of converting the organic fraction of the waste stream—newspapers, food, leaves, etc.—into compost. Large scale composting is a relatively new technique of processing waste in North America; because it is so new, very little information is available about siting MSW composting facilities. However, many experts feel that composting will play a major role in integrated solid waste management, since closure of a large number of U.S. landfills has eliminated burial as the most prevalent (and cheapest) option that can be considered by many communities. Along with recycling, composting is the number two priority in EPA's solid waste management hierarchy (behind source reduction and ahead of incineration and landfilling) (EPA).

Three New England cities were surveyed to provide data to investigate the siting problem: Keene (pop. 20,298) and Rochester (pop. 26,327), New Hampshire and Greenfield, Massachusetts (pop. 17,906). These cities were chosen due to their populations' different levels of familiarity with the solid waste problem and similar demographics. Keene recently had a proposal to construct an MSW composting facility defeated in a public referendum; Greenfield is currently considering an MSW composting facility as a solution to its waste management problems; and Rochester is home to New Hampshire's largest landfill, a materials recovery facility, and a sludge composting operation. The survey form was based on previous studies and on information obtained from focus groups conducted in Fremont and Chester, NH.[5]

Focus group results indicated that there was a dearth of knowledge about MSW composting among the general public. To the extent that focus group members understood composting, they tended to relate it to backyard composting of leaves, food scraps, and grass clippings. Rather than try to educate the survey respondents on the finer points of MSW composting, the following simple hypothetical was provided:

> WHAT IF . . . the public officials of your community were to recommend building a municipal solid waste compost facility. This facility would be enclosed in a building that would take the waste of your community and surrounding communities. It would process the organic part (leaves, paper, vacuum cleaner bags, food, diapers, etc.) to produce compost. Anything left over would be disposed of elsewhere. There would be 25 feet of trees around the facility. The facility would be built 300[6] feet from where you live.

We felt that this statement was a compromise between providing no information and providing so much information on MSW composting that respondents would "overload" and response rates would suffer accordingly.

Two thousand surveys were sent in a two-wave mailing to the three towns, weighted by relative population. A total of 749 questionnaires were returned for an effective response rate of 36.6 percent.

The Empirical Model

Since the problem posed to respondents was hypothetical, hypotheses specified to test the EU model were necessarily rudimentary. Individuals were felt to be displaying risk aversion within the EU framework if potential economic and environmental losses from a MSW composting facility were weighed more heavily than potential economic gains and respondents reacted to the potential facility in a way so that Θ might be minimized.

Respondents to the waste management survey were given the description above of the hypothetical MSW composting facility to be sited near their home. They were then asked "Would you accept this municipal solid waste compost facility 300 feet (1,000 feet, two miles) from where you live?" Respondents were given the options yes, no, and maybe. A yes response would indicate that the respondent felt having the facility nearby would increase expected utility, while a no response would suggest that the facility would cause a net loss of expected utility, because either c or Θ was unacceptably large. Interpreting the maybe response is more problematic; this response indicates uncertainty as to how the outcome will affect the individual. However, given the relative lack of knowledge of the general public on MSW composting revealed by the focus groups, the maybe option was necessary to give respondents a more realistic range of choices. Forcing respondents to choose yes or no in the absence of better information[7] would bias the results in an indeterminate fashion. These three responses provided the dependent variables for the multinomial logit model described below.

Thirty six percent of respondents answered yes, 33% no, and 30% maybe. Within this framework, a multinomial logit model was chosen for analysis of the data set. Luce and Suppes have shown that a logit model is a strict utility model consistent with the EU framework used in this study under the assumption that the random component of the probabilistic choice model is independent and identically distributed.

The multinomial logit model, like the dichotomous choice logit model, is based on the cumulative logistic probability function. As described by Hosmer and Lemeshow a three category model takes the form of two logit functions:

$$(5) \qquad g_1(x) = \ln\left[\frac{P(y=1|x)}{P(y=0|x)}\right] = \beta_{10} + \beta_{11}x_1 + \beta_{12}x_2 + \ldots + \beta_{1p}x_p = (1, x')\beta_1$$

$$(6) \quad g_2(x) = \ln\left[\frac{P(y=2|x)}{P(y=0|x)}\right]$$
$$= \beta_{20} + \beta_{21}x_1 + \beta_{22}x_2 + \ldots + \beta_{2p}x_p$$
$$= (1, x')\beta_2$$

where

$P(y = 0|x)$ = conditional probability of yes response (support for siting facility)
$P(y = 1|x)$ = conditional probability of no response (opposition to siting facility)
$P(y = 2|x)$ = conditional probability of maybe response (uncertainty regarding support for facility)
x_i = explanatory variables
β_j = estimated coefficients

It follows that the three conditional probabilities of each outcome category given the covariate vector are:

$$(7) \quad P(y=0|x) = \frac{1}{1+e^{g_1(x)}+e^{g_2(x)}}$$

$$(8) \quad P(y=1|x) = \frac{e^{g_1(x)}}{1+e^{g_1(x)}+e^{g_2(x)}}$$

$$(9) \quad P(y=2|x) = \frac{e^{g_2(x)}}{1+e^{g_1(x)}+e^{g_2(x)}}$$

This formulation is analogous to

$$\text{Prob}\,[\text{choice } j] = \frac{e^z}{\Sigma_y e^z}, j = 0, 1, 2$$

where

$z = \beta_j' x_{jt}$
t = observation
j = choice option

as described in Greene. Disturbance terms are assumed to be independently and identically distributed.

Variable Selection

In order to test the EU hypotheses noted above, three principal variables were specified: one relating to economic development created by the facility, one examining perceived environmental impacts of the facility, and a proxy for risk posed by the composting operation. The economic development variable corresponded to the positive characteristics of the a matrix, environmental impacts corresponded with c, and the risk proxy was a weak substitute for Θ.

The Environmental Impact and Economic Opportunity variables were derived from survey data using factor analysis, a data reduction technique which serves to remove duplicate information from among a set of variables and to group similar variables (Kachigan). Since factor analysis identifies groupings of variables that are highly correlated with one another, a single variable from each factor may be selected for inclusion among a set of potential predictor variables, thereby avoiding the problem of collinearity. Factor scores may also be used.

Factor analysis was employed on 14 attitudinal question responses to more clearly understand the attitudes toward impacts of the MSW composting facility. The factor analysis yielded two factors which were then rotated using orthogonal (varimax) transformation. These two factors explain nearly 100% of the variance. Factor 1 is labeled "Environmental Impact" and includes threaten health and safety of neighborhood, risks to children, create bad town image, pollute ground water, smell bad, decrease property values and increase noise pollution. It accounts for 80% of the variance. Factor 2, "Economic Opportunity," includes new jobs and economic growth. This factor explains 20% of the variance.

Higher factor scores for the Environmental Impact variable indicate more perceived negative environmental impacts of the facility such as threats to neighborhood health and safety, noxious odors, and pollution of ground water. Higher scores for Economic Opportunity demonstrate more optimism about job creation and economic growth due to the facility. These two variables were used to test whether environmental impact concerns did indeed tend to outweigh economic development benefits. Specifically, statistical significance and relative coefficient sizes were used to perform a crude test of the EU hypothesis with the expectation that either the coefficient of the environmental impact factor would be statistically significant and the coefficient of the economic development factor would not, or the coefficient of the environmental impact factor would be much larger than that of the economic development factor.

To accurately assess how respondents sought to minimize probability of occurrence of adverse events (Θ in equation 1), it was necessary to find a proxy for risk. By definition, NIMBY responses occur when individuals agree with the general need for the facility but disagree with its location in their own community. Thus, the greater the distance between the individual and the facility, the greater the probability that the individual would not display NIMBY behavior. Therefore, distance to the proposed facility was used as a proxy for perceived risk. One of the strongest empirical implications of NIMBY is the correlation of distance and the perception of costs and benefits. Studies have found that opposition to unwanted facilities decreases with distance (Lober; Furuseth and O'Callaghan; Marks and von Winterfeldt; Lindell and Earle). In other words, households closer to the unwanted facility will pay more through increased traffic and noise, reduced safety, increased risk (real or perceived), and potentially reduced land values.

A number of additional variables was added to enhance the model's predictive power. While these variables do not enter the individual utility function directly, it could be argued that utility functions vary by sociodemographic characteristics. In addition, while the dependent variable is an indicator of expected utility, it likely encompasses more than simply EU, and the inclusion of additional variables which affect attitudes is warranted.

Previous studies have identified a number of similarities in opponents (or proponents) to local facility siting. In general, older residents tend to be less likely to exhibit NIMBY behavior, while the presence of children in the household has been found to increase the sensitivity to facility impacts (Piller; Brehm and Rydant; Rydant; Zeiss and Atwater; Halstead et al.). Several studies have found that women tend to be less supportive of siting than men (Hamilton; Portney). Piller found that those involved in NIMBY activities had no particular affinity with environmental groups. Neither income nor education have been found to influence sensitivity to waste management facility siting (Zeiss and Atwater; Madisso). Past studies have also identified a fear of ground water contamination, property devaluation, and health risks as principal motivating factors in NIMBY behavior (Wirth and Heinz; Rydant).

Based on these previous studies and the benefit/cost/risk factors inherent in the EU framework, nine independent variables were included in the model (table 1).[8] Seven categorical variables were combined to create a measurement variable called the waste involvement measure or WIM. To compute the waste involvement measure, the responses to questions relating to household trash handling were used. For example, if the trash is picked up at the home, the respondent is not as actively involved in handling the trash as a respondent who takes the trash to a transfer station. If the respondent recycles, he/she is more involved. The range of the waste involvement measure is from 0 (being least involved) to 7 (most involved). Each behavior was weighted equally.

Table 1. Independent Variables Used in the Multinomial Logit Model

Variable Name	Description	Anticipated Sign[a]
Distance	Ft from proposed facility	(+)
Waste Involvement Measure (WIM)	0–7 scale	(+)
Environmental Impact	factor score	(−)
Economic Opportunity	factor score	(+)
No trust	factor score	(−)
Age	respondent's age (yrs)	(+)
Gender	1 if male, 0 otherwise	(+)
Children	1 if children under 18 in household, 0 otherwise	(−)
Income	Respondents income (dollars)	(−)

[a]Note that a positive anticipated coefficient sign means that an increase in the variable's value increases the probability of a "yes" (accept the facility) response, while the negative sign is interpreted as an increase in the variable's value leading to a decrease in the probability of a yes (or conversely, an increase in the probability of a "no" response).

Factor analysis was also performed on the respondent's level of trust in nine groups of waste management decision-makers, since trust in officials and developers has been identified as a key indicator in success or failure of siting attempts (Kunreuther, Fitzgerald, and Aarts; Bacot, Bowen, and Fitzgerald). One factor was identified which accounts for 92% of the total variance. It is interpreted as the "NoTrust-Bureaucrats" factor and is made up of state government, federal and regional agencies. The "NoTrust" factor was then given a score or linear composite. The score was formed by standardizing each variable to zero mean and unit variance, then weighting with factor score coefficients and summing for each factor (Hamilton). The factor score was used as an attitudinal variable in the multinomial logit model, and indicated the level of trust (or lack thereof) in state and federal government and regional agencies.

Results of Kunreuther and Easterling's work suggest that compensation in the form of a rebate is unlikely to have a positive effect on siting a facility unless the risk is perceived to be sufficiently low to an individual and to others, including future generations. In addition to Kunreuther and Easterling, the work of Peelle and Ellis and Brion suggests that before one attempts to initiate a compensation process, some threshold level of safety to nearby residents must be assured. Finally, Bacot, Bowen, and Fitzgerald found that environmental safeguards and government oversight tended to outweigh the importance of economic incentives, especially among those opposed to the facility. This also implies that actions/project characteristics that reduce risk will be weighted more heavily by respondents than factors such as job creation. Basically, for respondents where risk was perceived as too high, compensation was viewed not as inadequate, but as inappropriate. Because of these findings, and the hypothetical nature of the survey (that is, many respondents had little familiarity with MSW composting) a compensation/rebate variable was not included in the model. Although no specific compensation variable was included, the model's allowance for "tradeoffs' between environmental risks and economic benefits may be acting as a proxy for individuals' willingness to accept compensation.

Results

Results of the multinomial logit model are presented in table 2. The Distance, WIM, Environmental Impact, No Trust, Gender, Economic Opportunity, Age, and Income variable coefficients were all statistically significant at the 95% level or higher. In this case, a negative coefficient means that an increase in value of a given independent variable increases the odds of a "yes" response. All coefficients displayed the expected sign with the exception of age; model results indicate that younger respondents are more likely to accept a composting facility than older residents. This result is somewhat counterintuitive, as previous research has found that younger residents tend to be more prone to NIMBY behavior. This result may be due to younger respondents being more knowledgeable—and perhaps more optimistic—about composting. It may also be that younger respondents are more aware of the need for alternative disposal and management systems. In any case, this result may merit additional scrutiny in future studies. The coefficient of the No Trust variable indicates that as respondents' level of trust in the nine groups of waste management decision makers identified in the survey declined, they were less likely to accept an MSW composting facility within their community.

Regarding variables derived from the expected utility model, both the signs and significance of the Environmental Impact and Economic Opportunity variable coefficients are consistent with expectations. As noted previously, the risk averse nature of individuals involved in waste facility siting decisions would suggest that Environmental Impact would be weighed more heavily than Economic Opportunity; this is indeed the case as demonstrated by the relative sizes of the two coefficients (2.08 vs. –0.61).

The distance variable also exhibits the correct

Table 2. Summary of Results of the Multinomial Logit Model

Variable	Estimated Coefficient NO Response	Asymptotic T-Ratio NO Response	Estimated Coefficient MAYBE Response	Asymptotic T-Ratio MAYBE Response
Distance	–0.0002	–6.419***	–0.0001	–4.888***
WIM	–0.3155	–2.833***	–0.0629	–0.703
Environmental Impact	2.0803	8.822***	1.0509	4.845***
Economic Opportunity	–0.6078	–2.436**	–0.4751	–2.281**
No trust	0.6569	3.407***	0.1707	1.117
Age	0.0258	2.228**	–0.0043	–0.469
Gender	–0.8797	–2.616***	–0.7543	–2.753***
Children	0.4794	1.367	–0.0101	–0.037
Income	0.0374	4.330***	0.0181	2.616***
Constant	–0.0172	–0.017	1.529	1.890*

*** = Statistically significant at 99 percent level
** = Statistically significant at 95 percent level
* = Statistically significant at 90 percent level
n = 486
Chi-square (18 d.f.): 258.59
McFadden's R^2: 0.244

sign and is significant at the 99% level. This tends to confirm the EU supposition that respondents view composting facilities which are further away as posing less risk than those closer to their home.

The McFadden's R^2 of .244 indicates that the model has a moderate amount of predictive ability. The prediction success table (table 3) indicates that the model correctly predicts about 51% of all responses. The model is considerably better at predicting yes (59.1%) and no (56.4%) than maybe responses (36.1%).

Following Capps and Kramer, marginal probability changes resulting from one unit changes in the independent variables are presented in table 4. For example, an increase of one unit in the WIM index leads to an increase of 3% in the probability of a yes response, indicating that those individuals actively involved in composting, recycling, source reduction, and other activities are more likely to accept a facility than those less involved in managing their trash. When considering the polar cases of male vs. female, men are 11% more likely to respond yes than women. Note that for the three category model, the sum of the probability changes for yes, no, and maybe responses must always equal zero.

Discussion and Implications

The expected utility model appears to be a reasonable predictor of how respondents will react to the siting of a MSW composting facility. The three principal factors which EU theory prescribes would affect the decision process-benefits of the proposed facility, losses from the facility, and the (perceived) probability of various scenarios occurring—embodied by the variables in the multinomial logit model explain a substantial amount of the variation in siting decisions.

Based on the logit model results, several socio-demographic characteristics appear important in

Table 3. Prediction Success Table

		Actual Response			
		NO	YES	MAYBE	TOTAL
Predicted Response	NO	78	24	40	142
	YES	25	115	55	185
	MAYBE	39	56	54	149
	TOTAL	142	195	149	486

Percentage of correct NO predictions: 54.9
Percentage of correct YES predictions: 59.1
Percentage of correct MAYBE predictions: 361.
Overall percentage of correct predictions: 50.8

Table 4. Marginal Probability Changes Associated With Independent Variables

Variable	Change in Probability of YES Response	Change in Probability of NO Response	Change in Probability of MAYBE Response
Distance	<0.01	<0.01	<0.01
WIM	0.03	−0.06	0.03
Environmental Impact	0.12	−0.14	0.02
Economic Opportunity	−0.03	0.03	0.00
No trust	0.04	−0.08	0.04
Age	<0.01	<0.01	<0.01
Gender	−0.11	0.08	0.03
Children	−0.03	0.12	−0.09
Income	<0.01	<0.01	<0.01

determining siting preference: age, income, and gender. In particular, women seem less willing to accept a facility than men. Acceptance of the facility also increases as a function of distance; respondents were three times as likely to accept a facility two miles from their home as one 300 or 1,000 feet away. This emphasizes the importance of appropriate visual and "olfactory" buffer zones. Finally, perceived environmental impacts of a facility were extremely important in predicting responses—much more so than perceived economic impacts. This tends to confirm the notion that respondents are risk averse when it comes to waste management facilities, and any planned facility must adequately address environmental concerns, particularly regarding water quality and threats to health and safety.

The failure of the model to accurately predict even half of the maybe responses may demonstrate just how difficult it is for respondents to develop subjective probabilities of various scenarios. The coefficients of the distance, perceived environmental impact of the facility, perceived economic opportunity provided by the facility, gender, and income variables were all statistically significant in the maybe model, indicating for example that decreased environmental impacts of the facility would tend to shift the respondent from the maybe into the yes category. Still, the maybe model's poor performance as demonstrated by the rudimentary test in the prediction success table indicates that effort might be expended to shrink the maybe category, thereby increasing the number of "hard choices" (that is, yes or no). This would indicate a need for additional education and information provision in this area. Results from this survey shed light on who should provide this information; local solid waste managers, environmental groups, and university personnel were most trusted, while respondents had relatively little faith in state and federal governments and private industry.[9] Future studies might try to determine exactly why "maybes" are uncertain about the facility through debriefing or additional questions. Types of incentives which might sway maybes to yes within the questionnaire format might also be examined, similar to the approach used by Kasperson (1980).

Regarding the issue of attitudes vs. actions, several survey questions (not included in the logit model) are somewhat illuminating. Of those respondents who indicated that they were opposed to the facility: 78% said they would vote against the proposal; 32% said they would join a citizen's group; 31% would write letters; and 29% would go to court, if necessary (Whitcomb et al.). Thus, opponents of a facility might be expected to take well-defined action in opposition.

Principles of siting

Based on the model and survey results, the following principles for siting emerge: 1) be sure "trusted officials" are involved in the process. The interpretation of the No Trust variable bolsters this suggestion; 2) perceived risks are just as important—if not more so—than actual scientific risks. Results of our study show that environmental risks substantially influence acceptability of a composting facility; 3) realize that communities are interested in safety and empowerment first, and economic growth, compensation, and shared benefits only after all health and safety concerns are met. The relative magnitudes of the coefficients of the Environmental Impact and Economic Opportunity variables reinforce this recommendation. In addition, based on this study and other literature, communities are extremely concerned that sufficient monitoring of both inputs and outputs of the composting process takes place, and that future responsibility for the project be clearly specified before construction begins. Thus, early and meaningful public involvement and education are imperative. Finally, need for the facility must be clearly established; the community must be certain other options have been explored (Whitcomb et al.; Kunreuther, Fitzgerald, and Aarts).

Concluding Remarks

One questioin which our study could not answer was whether these results would be accepted in other communities, states, or regions. To draw definitive conclusions, our sample would have to be examined more closely for its representativeness. Less than half of those surveyed responded, raising the issue of non-response bias. The survey sample was drawn from individuals with registered motor vehicles; this list had a higher percentage of males than the general population and, as noted, males and females differ significantly with regard to siting attitudes. Still, the results of this model suggest that subsequent research with different groups would shed further light on this vexing problem.

Finally, one must never forget that opposition to siting proposals is often rational and legitimate. Nonexperts often see problems, issues, and solutions that "experts" miss; in the absence of this opposition the community may end up with the wrong types of facilities in the wrong places, too many facilities, or simply unsafe facilities (Freudenberg; Laws and Susskind; Fiorino).

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Notes

1. This approach of pricing community characteristics is analogous to the hedonic housing model used by Brookshire et al..
2. Acknowledging that "actual" probabilities are still often no more than best guess estimates.
3. Kahneman and Tversky (1979) and others have suggested prospect theory as an alternative to the EU model when decision makers weight losses more heavily than gains.
4. One notable exception was that respondents to the "hypothetical" survey felt that the facility would have "somewhat" or "a lot" of impact on property values near the facility, while respondents to the survey of communities where composting facilities are operating perceived very little negative impact on nearby properties.
5. Focus groups were assembled at random from the local phone book. Any individuals actively involved in waste management in their community (such as the local solid waste committee) were screened out, so that 10–12 participants per town were included. General questions posed to the groups related to general knowledge of MSW composting, possible benefits of the process, and concerns (both environmental and economic) from the facility. Further information on both survey and focus group results can be found in Whitcomb et al.
6. This distance was varied within the sample so that about one third of the surveys presented the facility 300 feet from the respondent's home, one third 1,000 feet, and one third two miles.
7. This better information would almost certainly be available if the community were making a final decision on siting a MSW composting facility.
8. Initially, a variable to differentiate the data sets by the three towns was included; however, the coefficient of this variable was not statistically significant, so the variable was dropped and the data were pooled.
9. For example, one study found that western communities placed very little trust in environmental groups, in contrast to this study's findings (Albrecht et al. 1985).