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Siting potentially hazardous facilities: what factors impact perceived and acceptable risk?

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Abstract

This paper examines two explanations for the acceptance of technological facilities in a community. One explanation argues that facilities are accepted as a function of the benefits and inherent risks associated with the technology involved. The alternative explanation argues that facilities are accepted on the basis of the conditions of acceptability. Because the former posits that facilities are accepted as a function of the technology, policies based on this explanation attempt to redistribute the risks and benefits associated with technologies to achieve fairness. The latter suggests that the acceptance of facilities that pose risk to the community is as much a function of the conditions of acceptability as it is the type of technology involved. From this perspective policy should be sensitive to the process of siting, construction, operation and shutdown of the facility in the context of the comprehensive relationship between the technology and the community (i.e., in an ecological sense). Rather than focusing on the characteristics of the technology, this perspective focuses on the social institutional arrangements that make the technology acceptable. This paper examines six different technologies and eight separate conditions of acceptability in terms of public perception and acceptability of risk. The pattern of responses from a 1992 national survey of the United States reveal a stable pattern from technology to technology among the eight conditions of acceptability. The importance of the conditions examined in determining acceptability provides insight into the siting process by demonstrating an emphasis on sustainability through empowerment of self-determination. © 1998 Elsevier Science B.V.

Keywords: Conditions of acceptance; Perceived risk; Incentives; Democracy; Capitalism

1. Introduction

Community attitudes have been shown to be important factors in planning and locating potential facilities. For example, Taylor et al. (1984) argue that '...strong opposition to proposed or existing facility location is clearly undesirable for both the users and providers...' of mental health services. Easterling (1992) finds that public opposition often thwarts efforts to site socially useful, but locally undesirable facilities (e.g., landfills, incinerators, nuclear power plants). Strong public opposition to public programs dealing with hazardous waste are often signalled by unfavorable attitudes toward those programs (MacGreagor et al., 1994). Because hazardous

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waste currently exists, the perception of risks at their present locations (Basset et al., 1996) or those associated with moving the waste (McBeth and Oaks, 1996) are also important in locational choices. Community sensitivity to hazardous waste facilities is an important component of the locational conflicts that often surround existing and proposed hazardous waste facilities (Furuseth, 1989). Clearly the salience of the risk for the population, particularly in the form of distance, is an important issue in siting controversies (Briassoulis, 1995), but it has also been argued that the perception of risk is an important factor in determining social behavior associated with technology (e.g., Mushkatel et al., 1989; Rayner and Cantor, 1987; Rogers, 1983, 1984, 1997; Slovic et al., 1979, 1985, 1986; Sorensen et al., 1987). Perception of health and safety risks are 'increasingly the central factor in explaining social behavior associated with hazardous technologies…' (Pijawka and Mushkatel, 1991), while ecological risks are beginning to be considered more carefully (McDaniels et al., 1995). This paper examines six different technologies and eight separate conditions of acceptability in terms of public perception and acceptability of risk in order to better understand the complex societal processes underlying perceived and acceptable risk associated with potentially hazardous facilities.

Historically there have been two major thrusts of research concerning the acceptability of facilities that bear risks. It has been widely recognized that people accept technology principally because of the benefits derived (e.g., Starr, 1969; Fischhoff et al., 1981). Some communities have opted to accept hazardous waste facilities, prisons and other potentially noxious facilities precisely because of the economic benefits they tender. Sometimes the acceptance of the facilities seems to be directly counter to the underlying community value system (e.g., Indian nations accepting hazardous waste sites). This view tends to place emphasis on the economic benefits of the facility or technology for the community. Another school of thought indicates that technologies that are particularly risky are not acceptable, regardless of the extent of associated benefits (e.g., Flynn et al., 1993). These 'locally undesirable land uses', or LULUs (Popper, 1981) are unacceptable at any price. From this perspective, ample evidence has shown that once the 'not-in-my-back-yard' or NIMBY syndrome is established in the siting process, it is difficult to overcome. This view tends to emphasize the risks associated with technology as the critical element triggering public outcry, protest and ensuing conflict.

More recently a third perspective has emerged, which views acceptability as a two-step process (Sokolowska and Tyszka, 1995). If the risk associated with a technology is perceived as too high, then the technology is deemed unacceptable and rejected. Once the technology is generally accepted, its benefits are examined as attitudes associated with it are formed. Hence, the more benefits that are linked to the technology, the more acceptable it becomes. In this manner the risks associated with a technology are critical to unacceptability, while benefits determine the level of acceptability among those that are generally acceptable. Whether risk acceptance is based on benefits, risk or some combination thereof, both risks and benefits are imbued in the type of technology. Therefore, the type of technology is expected to be a critical determinant of its acceptance.

This paper examines the acceptability of risk by type of technology to assess the role of benefits and risks in the acceptance of technological facilities. It examines data collected in a telephone survey of the contiguous United States in 1992. Respondent estimates of the likelihood of chronic and acute risks associated with three types of hazardous waste facilities and three types of energy production facilities are examined. The energy production facilities include a nuclear power plant, a conventional coal-fire power plant and a wind-farm for the production of electricity, while the hazardous waste facilities include an incinerator, a storage facility, and a transport depot.

An alternative explanation for why some technologies are deemed acceptable, while others remain unwanted is proposed. This alternative is based on the social structural approach to risk (Rogers, 1983), which posits that social structural processes regulate risk through the public's perception of risk in the determination of acceptable risk. Acceptability is discussed in terms of the conditions under which technologies are accepted in communities. Specifically, eight conditions of acceptability are examined for each energy production and hazardous waste facility, including: (1) having such facilities in the area; (2) having additional facilities; (3) giving companies tax incentives; (4) requiring advisory boards; (5) requiring monitoring; (6) requiring emergency plans; (7) asking companies to provide scholarships, road or community facility improvements; (8) giving control to public to improve safety. Each condition is examined to assess the its role in the acceptance of technological facilities.

2. Background

The siting literature generally deals with how the balance between risks and benefits effects the acceptability of various facilities. The utility of different practical incentives, compensatory measures and/or public participation and controls in creating public acceptability for potentially hazardous facilities is at the center of an unresolved, ongoing debate. For example, in some cases the public reacts negatively to monetary awards as 'bribes', but positively to apparently low-cost measures, such as the right to formally join in reviewing facility operations. Underlying the question about the best mix of such tools to facilitate the development of potentially hazardous facilities is a theoretical controversy about what drives public perceptions of technological developments. Compensation can be effective in gaining public acceptance for relatively benign facilities (e.g., landfills and prisons), but is subject to serious limitations when associated with facilities perceived to be either particularly risky or suspect legitimacy such as, waste repositories (Kunreuther and Easterling, 1996). This paper is part of an ongoing effort to synthesize the practical approaches to and theoretical understanding of the acceptance process.

Because of the inverse relationship between perceived risk (the estimation of the likelihood and severity of an event) and the degree of public acceptability associated with that risk (a form of valuation), siting decisions often focus on discussions of risk. Risk assessment was initially a scientific task of estimating the probability and consequences of undesirable events (Starr, 1969; Kates et al., 1985). The perspective was that if the risks are 'low enough' the public will find them 'acceptable'. Unfortunately, expert and public judgments seldom agree about risk (Slovic et al., 1979); they have even been described as rational arguments and irrational audiences (Kartez, 1989). Moreover, few LULU have turned the NIMBY syndrome into acceptable risks on the basis of reduced risk alone (Popper, 1981). In part, this has been because of the limited ability to alter the amount of risk. But it has also been the case because of often divergent, sometimes heated, but ever-present controversy over the amount of risk involved. This issue often comes down to a controversy over the risks estimated by experts as opposed to the public.

The perceived risk literature attempts to resolve these ongoing controversies by examining (a) psychological processes that bias risk preferences, such as 'heuristics' and 'schema'; (b) the communication of risk information; and (c) the socio-cultural value system at the root of judgmental biases. Psychological processes involving heuristics and schema have been examined to resolve public/expert controversies. The heuristic explanation treats untrained people as if they held similar judgmental biases. Based on psychometric studies, Kahneman and Tversky (1979, 1982) have even shown that people will reverse their choices of risky alternatives when equivalent alternatives are presented as a choice between a sure gain and a gamble, vs. a sure loss and a gamble. Judgmental heuristics have also generated controversy over the assessment of public preferences for risk. People initially estimate numbers resulting from complex processes (e.g., risk estimates), and then adjust them to arrive at a final answer. This anchoring effect can bias risk preferences when artificially high or low starting points are used (Fischhoff et al., 1980). Some have called for educational programs to teach the public how to remove the biases from their human judgments (Merkhofer, 1987; Rosenman et al., 1988), but such an effort is costly and unlikely to succeed. Raiffa (1985) found that even experts fall back on biased heuristic shortcuts when faced with problems outside their professional expertise.

Schema theories relax the assumption that cognitive heuristics are uniform; their very foundation is that people acquire and interpret facts differently, because of the different cognitive frameworks for becoming aware of, assimilating and applying new information. Schema are knowledge structures that result from training, experience and observation

(Graesser and Nakamura, 1982); they recognize and thrive on the person's environment as a factor in the social construction of reality (Holzner, 1968). Schematic thinking streamlines the cognitive processes by filtering new information on the basis of relevance (Kiesler and Sproull, 1982) and matching isolated observations to broader categories of information, related by casual assumptions (Fiske and Taylor, 1984). Schema can help people make inferences, predictions and decisions when faced with sketchy or missing information, but they can also lead to inferential leaps that are internally consistent, but externally erroneous. While schema account for the environment and social processes, as well as seemingly rigid views, changing a judgment requires a person to change the underlying schema (Lindblom, 1977). Unfortunately, policies could be developed to use schema in developing a marketing approach to acceptable risk (Earle and Cvetkovich, 1985), even though this might leave important aspects of the problem unresolved, or issues unexamined, and can be considered manipulative. Hence attempts to get the public to perceive risk the way experts do have not led significantly to enhanced acceptability of risk or eased the facility siting process.

If risk analysts could only communicate risk more effectively the differences between expert and the public perception of risk would be at least diminished (Covello et al., 1987; Needleman, 1990), which would in turn ease controversies surrounding facility siting. In the transition from 'all we have to do is get the numbers right', to 'all we have to do make them partners', (Fischhoff, 1995) citizen advisory committees are increasingly used to ease tensions associated with environmental concerns involving risk (Lynn and Busenberg, 1995). Risk communication can be informative, but unfortunately it can also be manipulative. Comparing technological risks with those associated with smoking subtly eliminates some alternatives (e.g., having both sets of risks). The cognitive studies of risk perception have produced underlying principles for predicting public acceptability (Slovic et al., 1985). Risks tend to be feared the most when they appear to be uncontrollable, irreversible, or have unknowable future impacts. Risk communication seeks to reduce the potential public hysteria in response to risk information. Unfortunately, risk communication can be viewed as industry or government propaganda, designed to deceive the public. Counting public fears as legitimate prospect costs while communicating risk to reduce distortions can be a useful approach to anticipate and deflect public opposition in the siting process (Kartez, 1989).

The cultural theory of preferences presents a challenge to judgmental heuristics, schema and risk communication by viewing differential biases as reflecting the socio-cultural values underpinning the pursuit of happiness, well-being, and the good life (Douglas and Wildavsky, 1982). Under this approach the approval of a given technology reflects a broader approval of the value system supporting that technology and the institutions managing the technology and any inherent risks. Krimsky and Plough (1988) point out that processes that are scientifically and technically rational are not culturally rational, making risk communication extremely difficult. Technical rationality depersonalizes precisely when cultural rationality personalizes. Rogers (1992) finds that cultural foundations can lead to a lack of communication about risk in environmental controversies. Rayner and Cantor (1987) argue that siting and acceptable risk are more a function of fairness in terms of public consent, distribution of liabilities, and trust in institutions, than of probability and magnitude. Social amplification of risk examines the communication process to conclude that hazards interact with social–cultural process to produce a public response that may amplify or attenuate perceived risk (Kasperson et al., 1988). Neither risk communication nor cultural theories of risk preferences provide satisfactory understanding of acceptable risk.

The risk management literature examines acceptable risk as a function of management, which often involves incentives. These incentives involve monetary gain, public participation in the siting process, and sometimes operational control. Risk management is another important element in the social acceptability of risk. Risk management includes reducing risk through improvements in the technology aimed at reducing the probability of an undesirable event, restricting land use near potentially hazardous facilities, and creating emergency response capabilities aimed at the reduction of potential consequences. For mechanisms to be effective (particularly in reducing consequences), not only must the risk be communicated effectively, but mitigation mechanisms must be shown to effectively reduce the associated risks (Mileti and Fitzpatrick, 1991). Rogers (1983) makes the argument that the social structure manages societal risk. Risks are managed by individuals, families, private firms, communities (most communities have specific emergency management organizations for this function), and both state and federal governments.

At least in terms of nuclear power, the public generally finds it more acceptable to locate LULUs elsewhere (Melber et al., 1977 and Nehnevajsa, 1979). People residing near nuclear power plants rate the production of electricity in nuclear power plants as more acceptable than people living elsewhere. Rogers (1984) examined this apparent paradox with data prior to Three Mile Island (TMI) in terms of four hypotheses involving experience, cognitive dissonance, predisposition, and altruism. After a systematic elimination of alternatives, the cumulative experience of nearby residents combined with a relatively low-probability risk and the predisposition-education–economic benefits are found to make nuclear power more acceptable. Rogers (1983) examined four kinds of life experience in relation to perceived and acceptable risk: direct experience via living near a nuclear facility, combat experience, disaster experience and residential mobility. Only direct experience of living near a nuclear plant was found to be related to perceived risk and acceptable risk. This relatively accident-free experience served to reduce perceived risk and thereby make it more acceptable. However, this was based on public attitudes about nuclear energy prior to TMI.

A general finding suggests that people with previous experience with hazards, particularly among those with a direct economic relationship with the hazard, are more likely to have an accurate perception of the risks involved (e.g., Kates, 1971; Burton and Kates, 1964). Soderstrom et al. (1984) examine perceived risk in an interest group context after the TMI accident during the restart process. Their results seem to confirm that '...when physical reality becomes increasingly uncertain, people rely more and more on social reality.' This means that accidents like TMI may be interpreted by residents as either confirming the risk, or safety, depending on one's perspective prior to the event. In his examination of the effect Chernobyl had on perceived risks of nuclear power, McDaniels (1988) notes that there is surprisingly little work published on the effect of accidents on perceived risk. This pilot study found that even with small samples of adults, Chernobyl had effects on the ways people perceived risk in the United States. Rogers (1997) examines perceived risk before and after a chemical plant fire and a contentious hazardous waste incinerator permitting process, concluding that while people learn from hazardous events, the impacts of these risk events on perceived risk are neither as strong nor as patterned as expected. While none of these studies whether experience increases or decreases perceived risk, they all point to a complex relationship between experience, perceived risk and its social context (Drabek, 1986). Starr (1984) argues that if LULUs are to gain public acceptance, the public must have confidence in the facility's management. Rogers and Haimes (1987) argue that public confidence in prison management is more important than the probability of escape (risk) or the potential benefits. Bord and O'Connor (1990) confirm the relationship of trust to acceptability among adult women. Their most consistent and dramatic finding is that trust in the specific industry, industry in general, government regulatory agencies, and in science itself are all important in gaining public acceptance of technology.

Hostile local opinion is the principal impediment to siting new nuclear waste facilities (Miller, 1987; Metz, 1994; Slovic et al., 1994); even though compensation may be used to assure fairness in the siting process. Mechanisms for resolving conflicts over siting of noxious and obnoxious facilities rarely produce optimum results (Sorensen et al., 1984); environmental mediation through the adoption of incentive systems can engender public confidence and support by addressing the substantive concerns underlying the conflict. Carnes et al. (1983) find that incentives are more likely to enhance acceptability when they mitigate risk potential than if they simply compensate or reward. However, incentives are unlikely to enhance acceptability without attaining public health and safety, at least some local control, and legitimate negotiations during the siting process. Feldman et al. (1989) examine an intergovernmental consultation and coordination board as a means of legitimating public participation in a siting process.

Important elements of risk management include: who manages the risk? how much credibility do they have? and can we trust them to manage the risk?

3. Accepting potentially hazardous facilities

This paper examines two alternative explanations for the acceptance of technological facilities in a community. One explanation argues that technological facilities are accepted based on their benefits (e.g., the benefits are worth the risks the facility generates), or their risks (e.g., the risks are too high regardless of the potential or actual benefits), or both (e.g., once the risk is determined to be reasonable, acceptance is directly related to benefit). In any event, this perspective posits that acceptability is a function of the technology. If this explanation is correct, it can be anticipated that the type of technology is a critical factor in the acceptance of potentially hazardous facilities or technologies. Hence, policy makers must be sensitive to the characteristics of the technology in their regulation of technological risks. Policies may attempt to balance the risks and benefits associated with potentially hazardous facilities. In short, policies in this category attempt to redistribute the risks and benefits associated with technologies to achieve fairness through a better or more appropriate balance of risks and benefits.

Because technologies have been the focus of many studies (Lowrance, 1976; Lawless, 1977; Slovic et al., 1986), the technologies selected herein represent a broad spectrum of the attributes suggested in the literature as important to the perception and acceptability of risk. Table 1 presents a brief summary of the attributes associated with the various technologies selected. While these characteristics are somewhat arbitrary, representing the judgment of the author as informed by the literature, they are not expected to fully represent the attributes of the risks presented by the technologies selected; nor are they expected to fully represent the variation associated with the distribution of judgments that form these attributes. The risks presented by these three energy production and hazardous waste technologies represent a variety of attributes and should be expected, even if there were some unrecognized similarities in the distribution of attributes, to represent a distribution of risk that would be acceptable under a variety of circumstances.

The alternative explanation argues that technological facilities are accepted on the basis of the condi-

Table 1
Comparison of risk attributes of selected technologies

	Generation of electricity			Hazardous waste		
	Wind power	Coal power[a]	Nuclear power[a]	Storage[a]	Incineration	Transport
Uncontrollable	Low	Med.	High	High	M–H	Med.
Dread	Low	Med.	High	High	High	M–H
Global catastrophic	Low	Med.	High	Med.	Med.	Med.
Fatal consequences	Low	Med.	High	High	M–H	M–H
Inequitable	L–M	Med.	High	High	High	Med.
Catastrophic	Low	Med.	High	High	M–H	M–H
Future generation risk	Low	Med.	High	High	High	M–H
Not easily reduced	L–M	Med.	High	High	M–H	Med.
Risk increasing	Low	Med.	High	M–H	M–H	M–H
Involuntary	L–M	Med.	High	High	High	Med.
Affects me	Low	Med.	High	M–H	M–H	M–H
Unobservable	Med.	Med.	M–H	M–H	M–H	L–M
Unknown exposure	Med.	Med.	High	M–H	High	Med.
Effect delayed	L–M	Med.	High	High	High	M–H
New risk	Med.	Med.	High	M–H	M–H	L–M
Risk unknown to science	Low	Med.	M–H	Med.	M–H	L–M

[a]Adapted from Slovic et al., 1986.

tions of acceptability, suggesting that the acceptance of a potentially hazardous facility is as much a function of the conditions of acceptability as it is the type of facility. These conditions include public participation, technological safety systems, emergency preparedness, community and personal incentives, and operational control. This perspective posits that technological facilities are accepted not simply on the basis of the technology and its inherent risks and benefits, but rather on the broad full-cycle bundle of factors that characterize the relationship of the facility to the community. Hence, acceptability is at least as much a function of the process of acceptance as it is of the characteristics of the technology. In this case, policy makers should be sensitive to the process of siting, construction, operation and shutdown of the facility in the context of the comprehensive relationship between the technology and the community (i.e., in an ecological sense). A fundamental policy question arises—What needs to be done to make an equitable relationship (i.e., that includes both present and future generations) sustainable? One way to sustain this equitable relationship is to institutionalize critical aspects of the conditions of acceptability. So rather than focusing on the characteristics of the technology, this perspective focuses on the social–institutional arrangements that make the technology acceptable.

4. Data and methods

The United States is represented with a sample of a minimum of 305, and maximum of 429 respondents, depending on which questions are being analyzed, resulting in a sampling error between 5.7% and 4.8%. The public acceptability surveys were conducted using the facilities of the Texas A&M Public Policy Resources Laboratory (PPRL). Experienced interviewers were trained and supervised by both the research team and the PPRL's monitors. The fieldwork period included weekends to optimize data collection and yield the highest possible response rates. Fieldwork began on February 23, 1992 and ended April 7, 1992.

The total design method (Dillman, 1978) was used to insure the highest possible response rates for this type of survey (i.e., resulting item response rates range between 50.7% and 64.5%).[1] This method involves a minimum of five call backs to non-responders, and a thorough explanation of the purpose, benefits and importance of respondent participation in the research. In addition this research used computer-assisted-telephone-interviewing (CATI) to maximize interviewer effectiveness. To ease respondent burden and insure reliable results the public acceptability surveys were designed of primarily close-ended questions and required an average of 28 minutes to complete.

Data collected include attitudes concerning the likelihood of potential accidents, a series of Likert-scaled items regarding favorability of waste, and energy production facilities being sited nearby under various social, governmental and institutional arrangements, a personal risk profile, and household characteristics (e.g., household size and ages, income, length of residence). The survey items for perceived risk were presented in random order to minimize the impact of order bias. The blocks of items concerning the acceptability of various technologies were also presented in a random order, and the items within these blocks concerning were presented in random order.

A series of guided open-ended questions elicited spontaneous response that reflect the respondent's general view of the community and the risks faced therein. These questions provide community contextual meaning for the perception and acceptability of risk. The respondents were first asked, ''what is the most important problem facing people in your community today?'' Spontaneous responses to this item were coded into a variety of categories including, (a) environment or pollution problems, (b) economic, recession, unemployment, or lack of jobs, (c) health and safety problems, and (d) crime and drugs. The

[1] In order to reduce respondent burden and shorten the overall interview one of the five blocks of questions (all except wind farms) regarding the acceptability these technologies was dropped at random from the questionnaire. Hence, the overall sample size is reduced for these blocks of items, because some respondents were not given the opportunity to respond to these items. The effective sample sizes for these items are nuclear power 622, conventional power 602, hazardous waste storage 607, hazardous waste incineration 606, hazardous waste transport depot 604, and wind farms 665

responses to this question are used to establish the social economic context for the present analysis.

Perceived risk was measured on a five-point Likert scale. This index was used to assess the respondent's view regarding the likelihood the occurrence of an event as being 'very likely, somewhat likely, a 50–50 chance, somewhat unlikely, or very unlikely'. This scale was mentioned before each block of likelihood items to set the format, but the respondents were simply asked, ''how likely is it that'' a given event will occur. Acute and chronic items were presented for each technology. In most cases routine releases of air-borne and water-borne toxic materials were used to represent chronic hazards, and explosions injuring or exposing the public were used to represent acute hazards; however, acute nuclear risks were assessed in terms of '... a major accident... releasing radioactive fallout'. The distinction between acute and chronic risks was least clear for hazardous waste transportation risks. Chronic risks were represented as 'an accident... exposing residents to toxic materials', while acute risks were represented by '... a truck... crashes exposing resident to toxic materials'. The risks associated with wind farms were characterized in terms of (a) the general risk of 'decreased property values... because of noise', (b) the chronic risk of exposure to 'electrical magnetic fields', and (c) the acute risk of 'a fire starts... resulting in nearby homes being destroyed'. Binary variables were used to represent each response representing a value greater than 50–50 chance. This measurement technique takes advantage of a common understanding of a 50–50 chance like the toss of a fair coin, and allows the measure to be used as a binary variable with all its inherent advantages.

Respondents assessed the acceptability of each technology in terms of its favorability, which is assessed on a five-point scale ranging from 'strongly favor', to 'strongly oppose'. The scale was repeated at the beginning of each block of questions representing each technology; however, the extreme responses were not repeated with each question, and the neutral center point was used only if the respondent spontaneously responded a neutral response. The acceptability of the six technologies is assessed under eight conditions: (1) having a facility; (2) offering tax incentives to facility operators; (3) requiring continuous monitoring; (4) requiring emergency plans; (5) requiring community advisory boards to keep the public informed; (6) asking facilities to offer community incentives; (7) giving nearby residents reduced tax or utility rates; and (8) giving nearby residents authority to change operations to improve safety. These eight items represent a baseline at two extremes (1 and 2 above), risk mitigation mechanisms (3 and 4), informational programs (5), direct and indirect compensation (7 and 6, respectively), and operational control (8). Items 3 through 8 are active, in the sense of representing divergence from the status quo. To represent the full range of alternatives having a facility and offering tax incentives to companies to locate facilities in their community were included. However, it is not possible to represent not having items 3 through 8, because simply not requiring or not asking for emergency plans or monitoring, does not mean that companies will not provide it on their own. These five-point scales were subsequently recoded to a binary variable where 'strongly favor' and 'favor' responses are equal to one, and all other responses are assigned zero. This binary distribution can be interpreted as the degree of favorable response to each item.

Having discussed the variety of actions that might effect the acceptability of the various technologies, the respondents were asked to indicate 'which of those actions... increase or decrease the risk for nearby residents', and 'which of these actions ... significantly increase the costs'. These items were used to attain a deeper understanding of the meaning underlying the favorability of each acceptability item. For example, a respondent may oppose offering tax incentives to companies, but without these items on increased or decreased risk and costs, it would be impossible to know whether this opposition is grounded in increased risk associated with additional facilities being attracted to locate in the area or increased costs associated with tax revenues being reduced.

5. Findings

On the whole, the economic conditions in its various forms of needing jobs, unemployment, and recession, were mentioned most often by our respondents as the most important problem facing people in their community. In fact, more than 50% indicated the economy was the most important problem, followed by crime and/or drugs and health and safety with just over 8% each. This is more than a 6:1 ratio. Only 4% mentioned environmental problems as the most important problem facing people in their community. This is a ratio of more than 13:1. People across the nation clearly were concerned about their community's economic future in the Spring of 1992. This was externally validated by a successful presidential campaign which reminded itself frequently that, 'it's the economy, stupid'!

Fig. 1 shows the proportion of people rating the acute and chronic risks above the 50–50 level for each of the six technologies. More than one person in five (20%) rated the risks as greater than a 50–50 chance for all six technologies. Both waste storage risks (seepage causing life-threatening diseases), and acute waste depot risk (truck crash exposing residents) had more than 50% of the respondents rating the associated likelihood above the 50–50 level. It is important to note that all hazardous waste risks (i.e., storage, transport, and incineration), both chronic and acute, are consistently rated higher than the chronic or acute risks associated with the generation of electricity in nuclear power plants. Moreover, the chronic risks associated with conventional coal-fired power plants are also more likely to be rated as greater than a 50–50 chance than are the risks of nuclear power generation. However, the acute risks associated with coal-fired plants are rated substantially below the risks of either chronic or acute nuclear risks. Both the chronic and acute risks associated with the generation of electricity in wind farms are rated below the other posited technological risks. In any event these risks are viewed as substantial. By no means could these perceived risks, even those associated with wind farms, be considered trivial. It is in this sense that both the risks and benefits of facilities such as these are perceived as significant.

It might be anticipated that people harboring economic concerns would be more accepting of technological facilities in their communities. Simply put, the underlying motivation is that if people are concerned about the economy then they are more likely to emphasize the benefits of the facilities for the local economy. In short, they are more likely to focus on the (potential) jobs and other indirect benefits than on the risk so they will be more accepting. Yet respondents expressing economic concerns as the most important problem rated the chronic and acute risks associated with the six technological facilities similarly to those who chose other problems as the most important problem facing the community. Of the two tests for each of the six technologies

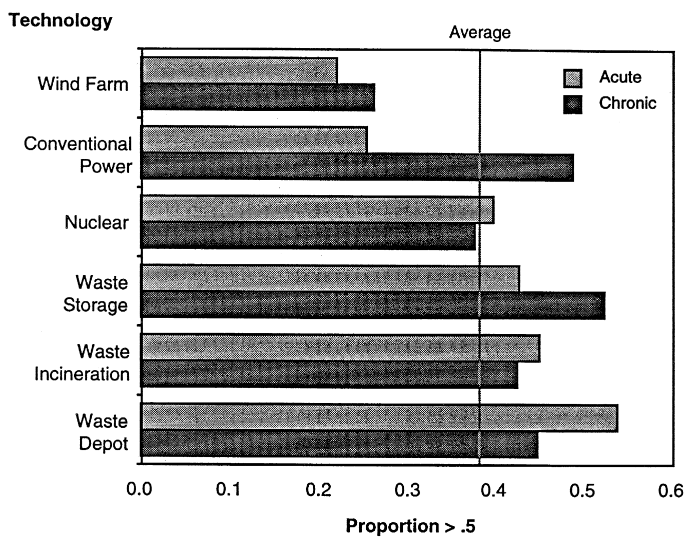

Fig. 1. Likelihood of acute and chronic technological risk (National Spring 1992).

(12 tests in all), none showed a significant relationship with economic concerns as the most important problem facing the community. This suggests that people do not adjust their perception of risk (or at least their risk estimates) to accommodate perceived economic needs in the community. But do economic needs drive acceptability?

To better understand the nature of the degree of acceptability of each technology Fig. 2 represents the proportion of people 'favoring' or 'strongly favoring' the technology with a series of randomly presented incentives. The proportion of respondents favoring each technology is lowest when assessed in terms of having a facility in their community. In fact, only wind farms had more than half of the respondents favoring having a facility in their community, or offering tax incentives to attract more of these kinds of facilities. Conventional power plants are the next most acceptable technology with just under half 'favoring' or 'strongly favoring' having them in their community, or offering tax incentives to companies that might develop coal-fired electrical plants. On the other extreme, waste storage and incineration are the least favored technologies, with under 25% 'favoring' or 'strongly favoring' having these facilities in their community.

Respondents were least likely to favor offering tax incentives to companies to develop nuclear power plants in their community. Moreover, tax incentives to attract nuclear power stations was the least favored 'active' alternative examined (i.e., active in the sense of doing something to attract, mitigate, compensate or provide information). Having hazardous waste storage or incinerator facilities or nuclear power plants are considered 'passive' in that there is no action to attract, compensate, mitigate or inform. Direct compensation in the form of reduced tax or utility rates were next to the least favored active alternative considered. About 60% of the respondents favored offering this type of incentive in conjunction with these technologies, with only conventional power being slightly lower at about 58% favoring.

In contrast, more than nine out of ten respondents 'favored' or 'strongly favored' emergency plans, community advisory boards, and continuous monitoring on the whole. There seems to be a recognition of the need for these activities in that about 95% of the respondents favored having them for the other technologies, while only 89% favored requiring emergency plans, and 88% favored community advisory boards for wind farms. Continuous monitoring of

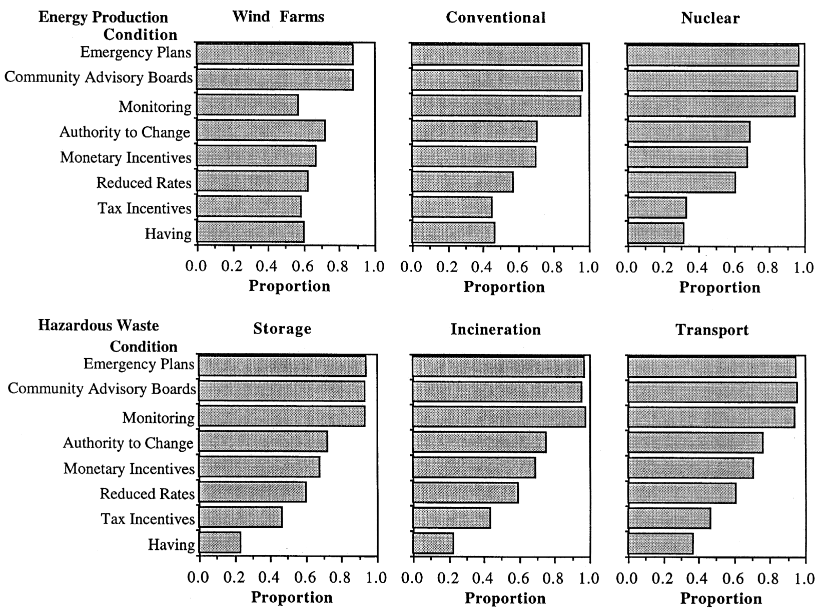

Fig. 2. Proportion favoring incentive by technology (National Spring 1992).

wind farms was assessed only in terms of the favoring '...them even if they were noisy?' Because continuous monitoring was not used in the item, it cannot be compared to the others.

Giving authority to nearby residents to change operations to improve safety was significantly less likely to be favored than requiring emergency plans, continuous monitoring or community advisory boards. About 72% of the respondents 'favored', or 'strongly favored' giving authority to nearby residents, which is about 20 percentage points below the hazard mitigation and public informational alternatives. On the other side, people favor giving nearby residents authority to change operations to improve safety more than giving nearby residents direct incentives, by about 12 percentage points. In addition, giving authority to change operations was favored by more respondents than providing indirect incentives. About 70% of the people 'favored', or 'strongly favored', asking facility operators to provide college scholarships, recreational facilities, or improve roads in the community.

To what extent is the acceptance of a risk related to the degree of perceived risk? The relationship between perceived risk and the eight conditions of acceptability were examined within technology type (e.g., conditions for accepting waste incinerator facilities were examined in terms of chronic and acute waste incinerator risks). Only 13.5% of the Pearson correlations for each of the eight conditions with the perception of both acute and chronic risks for each facility type were found to be significant. While 14.6% of the perceived acute risks were found to be significantly related to acceptability items, only 12.9% of the chronic risks were significantly related to the conditions of acceptability. In addition, responses that noted economic conditions as the most important issue facing people in their community were compared with those that found other types of problems more important in their community in terms of the acceptability of various technologies. Only one in six items (or 16.7%) were found to be significantly related to the perceived economic conditions of the community. Hence, economic benefits show no strong pattern of relationship with the acceptability of technological facilities.

The pattern of technological acceptability for these situations is clearly more driven by the conditions, than by either the risks or the benefits associated with the technologies. The within-condition differences are relatively small, compared to the between-condition differences. Within conditions, only 11.9% of the differences among technologies are significant. Conversely, the within-technology differences are relatively large compared to those across conditions. More than half (58.3%) of the differences between conditions are significant within technologies. The pattern among conditions tends to remain stable regardless of technology. Even though there are some minor variations, the pattern is relatively robust.

Because favoring/opposing these items can be interpreted to mean favoring or opposing either the technology, the incentive, or the degree of implementation (e.g., require, ask, insist, recommend, suggest), respondents were asked which of these actions increased or decreased risk, or increased costs. Two general types of response patterns emerged. First, people that found that the specified conditions reduced risk, which may be thought of as reasons given for favoring a condition. Even though for a limited number of these people there was a recognition of a significant increase in costs as well. Second, people recognized a significant increase in costs, especially a significant increase in risk for their community under the specified condition, which may be thought of as reasons given for opposing a condition. It is certainly difficult to imagine a circumstance where a respondent would favor the condition, because of increased costs and risks, or oppose it, because of decreased risk.

Fig. 3 presents the reasons given for favoring or opposing each condition in the context of the considered technologies. Holding the order of the conditions constant from the most favored (Fig. 2) to the least favored, the reasons given for those attitudes are monotonic: decreasing proportions mentioning reduced risk from emergency plans to having a facility in the community, and increasing proportions of increased costs. The reasons given for favoring emergency plans, advisory boards, monitoring, and authority to change are dominated by risk reduction, even though it may involve increased costs. Conversely, the reasons given for having the facility in the community, offering tax incentives and direct incentives in the form of reduced rates are dominated

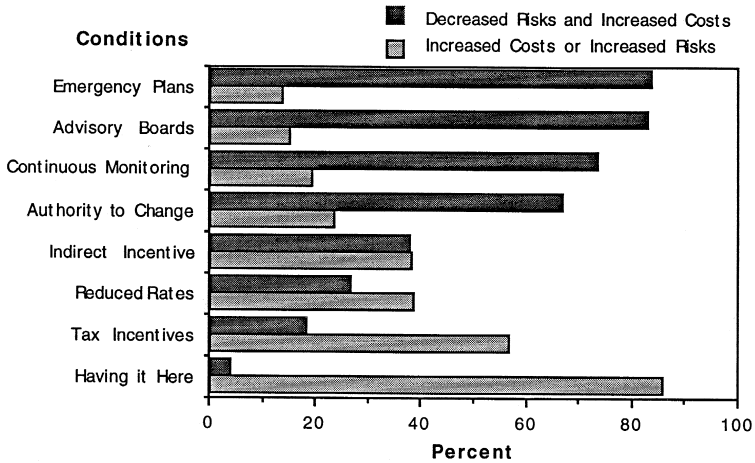

Fig. 3. Reasons given for favoring or opposing (National Spring 1992).

by increased costs, and some also mention increased risk as well. Just about as many people said they favored offering indirect incentives, in the form of college scholarships, parks and recreational areas and improved roads because of decreased risks, as opposed to increased costs.

6. Discussion

Even though these technologies and their associated risks were selected because they are different, the conditions of acceptance are more important than the technology when it comes to their acceptability. This finding is unique in that it emphasizes the conditions under which the risk is accepted rather than the characteristics of the risk itself. This is eminently reasonable in that people accept risk on a more or less continuous basis, not so much on the basis of the amount of risk, but rather on the conditions of the acceptance. For example, when a sky-diver decides to jump from a perfectly good airplane, s/he accepts the associated risks; but few would accept the risk without the condition of the parachute, or the training needed to participate in this activity safely. When a person decides to ride in a automobile, they accept the associated risks. But few(er) would take that ride if they knew of an existing safety problem (e.g., bad brakes or a drunk driver). Moreover, many people would refuse to ride in a vehicle without some knowledge of the risks presented (e.g., who is the driver, or knowledge of a certification of some kind). In fact, accepting risk on the basis of the conditions under which it is presented, is quite rational in the sense that it relies on human or social systems that are used in this manner on a regular basis. Starr (1984) suggested a similar argument that risk acceptance is driven more by the degree of trust in the risk management system than in the degree of risk the technology presents. The argument herein is somewhat broader, in that it applies not just to systems of risk management but rather to social systems that can include risk management, but also include risk communication, knowledge, social power and experience. People generally accept the risk associated with technology on the basis of the conditions of acceptance rather than on the basis of the technology alone.

What are the principles that guide these social systems in their determination of acceptable risk? Traditional economic analysis has placed emphasis on the balance of risk and benefit. These analyses have not proven wholly satisfactory in the determination of what technologies are found to be acceptable even though they involve risk. One can argue that if risks are considered as legitimate costs, cost-benefit analysis will include potential hazards presented to the public, but this does not address the social processes that effect the very nature of what is acceptable. While remaining the object of speculation in this article, two fundamental principles seem to impact what is determined to be acceptable (at least in the United States): principles of democracy, and capitalism. These two underlying principles may be thought of as establishing a level playing field. The principles of democracy seem to dictate that risks are more acceptable if a free flow of information about the risks can be established. People cannot be expected to either accept or reject a given technology if they simply have no information about it. Moreover, to establish its credibility, they must have a degree of confidence in the available information. Enter concepts of trust, credibility, fairness and informed choice. Principles of capitalism would suggest that whatever is required, expected or asked of one economic actor in a class (e.g., defined in terms of externalities) will be asked of all actors in that class, introducing concepts of fair-play, competition, free-market, and marginal utility. Simply put, people are not likely to favor special conditions for specified technologies involving risk.

The direct involvement of these two cornerstone principles of the society under study is somewhat less than surprising. It might be more surprising if the principles of democracy and capitalism were not involved in the determination what is acceptable. What do the findings regarding conditions of acceptability tell us about the limitations and processes implied? The nearly universally favored emergency preparedness plans seem to indicate that people require safety, so any mechanisms that are likely to provide additional safety will be favored. But requiring emergency plans is not universally favored. The generation of electricity in wind farms shows that when risk is low, implying that emergency plans are not particularly needed, people find no need to burden the economic actor with any ‘marginal’ safety gained by emergency plans. In this sense, because the burden of emergency plans is viewed as unnecessary, even though it is considered quite minimal, it is interpreted as regulation that biases the free-market against the generation of electricity in wind farms, and thereby in violation of capitalistic principles.

The widespread commitment to community advisory boards to provide information about nearby facilities seems to underscore the democratic principle of informed choice, and the economic principles of ‘buyer beware’. On the one hand, people require information to exercise freedom of choice (e.g., to live in a particular area or way). However, people cannot make these informed choices without a free-flow of information (i.e., a monologue of information from the company to the public) to help the public be aware of potential dangers. Community advisory boards simultaneously address both these principles. A freer flow of information helps assure the public that their interests are taken into consideration (i.e., a dialogue of information exchange between the company and the public where each influences the other’s actions) while informing them of potential obstacles and technological limitations. A community advisory board can help identify alternatives, while evaluating their credibility and effectiveness. Community advisory boards seem to push beyond availability of information providing access; moreover these boards tend to take active roles rather than passively waiting for additional information. These characters seem to maximize the likelihood of a facility being acceptable.

At the other extreme, having potentially hazardous facilities in the community or inviting additional facilities by offering tax incentives is favored by the less than half of the public. Being opposed to having facilities in the community may represent some perceived inequities in the current system: lack of information flow, failure to include use of common resources (e.g., pollution, potential risk, and community stigma) in the economic costs, and differential political influence. These increased costs exhibit a fundamental violation of the economic principles of fairness. Hence in this respect, people seem to that if facility operators include all the costs of the enterprise, including those costs borne by the community (i.e., both economic and the less tangible social costs), then they are more likely to be acceptable. However, offering companies tax incentives to locate in a particular community is fundamentally at odds with bearing their ‘fair share’ of these costs. Moreover, it is fundamentally at odds with the capitalistic principles of fairness. Why should they benefit more economically than any other company?

Likewise, offering nearby residents direct incentives, in the form of tax or utility rate breaks, is viewed as unnecessary, unfair and costly. These kinds of direct incentives are unnecessary because the people living there made the choice to live near an existing property, and they can choose to change their residence if they feel they should. Moreover, if the market were truly free, there would be little doubt that such movements would factor any economic incentive into the market value of nearby properties, which would in turn make tax breaks unnecessary. From the perspective of those people not receiving the direct monetary incentive, it is unfair because they chose to live near existing facilities. Given an appropriate level of community participation and information for new facilities, the principles of democracy should be sufficient to assure community protection and safety. Hence, if community participation, information, and safety are not an integral element of the process, indirect community incentives, in the form of scholarships, and community improvements, are likely to be seen as bribes rather than good community citizenship.

Giving the authority to change the way a facility operates to improve safety is less likely to improve its acceptability than continuous monitoring, community advisory boards and emergency plans, and more likely than direct and indirect monetary incentives and offering tax incentives to attract more facilities. Operational control of this variety would seem like the ultimate democratic operation of potentially hazardous facilities, but economic factors seem to be operating. While some people see the authority to change operations as likely to reduce risk, others find it potentially increases costs, and perhaps even increases risk. Put in this light, it is as though respondents are telling us, it is not right for residents to run the facility's business, any more than it would be right for the facility operators to manage the resident's household finances. The public seems to recognize that the facility operators are most capable of operating the facilities, but want it done right, in the sense that it involves more than simply economic costs of production. Facilities must assure a reasonable environmental quality for the community of location. Given that a safe operation can be established, the community's political right to swing its collective arm stops just before it reaches the facility's economically vulnerable eye. Establishing special regulatory rules for specific facilities biases the rules of the game to favor some at the expense of others.

7. Conclusion

Perhaps the most important conclusion to be drawn from this research is that nothing can replace safety. This does not mean that unsafe facilities can never be accepted, but rather that reducing risk is the best way to improve acceptability. No principles of communication, information, fairness, or fair-play can overcome legitimately perceived risk associated with facilities. In short, if operations are believed by the public to be unsafe, no incentive will change this perspective unless it fundamentally alters this belief. Facing a public that believes its operations are risky, a potentially hazardous facility must establish safety. Moreover, this safety must be established not only in company-defined terms, but in terms of the public's concept of safety. Perhaps first and foremost, but certainly among the most important actions a company can take to establish credibility and trust regarding safety, is to open the processes aimed at achieving safety, both among employees and to the public. Company credibility is vulnerable when fundamentally unsafe operations, even with superficial safety actions and/or good public relations efforts, attempt to replace genuine safety. Operators of potentially hazardous facilities must assume that no actions regarding safety are hidden from public view. By inviting public and employee participation in all actions, the fundamental concern for public and employee safety are underscored, and credibility and trust are engendered.

Under the principles of democracy, actions posing risk to the public or employees require the establishment of a free flow of information about the risk. However, one cannot assume that simply providing information is sufficient, a dialogue must be established to assure those concerned that what they think and feel is important. One way to assure the people that their concerns matter is to let their concerns shape how and what actions are taken at the facility. Ask for their participation and input on key events and activities. Take their concerns and suggestions seriously, and act accordingly. No doubt these steps to include people rather than exclude, will take extra time if done well, but enhanced public confidence, trust and support are rewards worth the effort.

For facility operators, as with other community leaders, no action is viewed in isolation from others. Hence, on the negative side, a leopard does not change its spots. Patterns of abuse are relatively easy to establish and very difficult to change. On the positive side, patterns of genuine concern, particularly those conditioned by dialogue, are likely to be helpful if things do go wrong. A strong pattern of concern for safety is reinforced after unfortunate events, by demonstrating how things went wrong and outlining what steps are being taken to prevent future occurrences.

Given that principles of democracy and capitalism guide public thinking about potentially hazardous facilities, and that the United States is a democratic–capitalistic system, why are the concerns of nearby residents an issue at all? The most simplistic explanation is that the principles suggested herein are ideal-type democratic and capitalistic guidelines, but hazardous facility situations are driven by democratic and capitalistic systems that are less than ideal. For example, these systems have not historically been guided by a free flow of information, open dialogue with the public and regulatory structures geared to fairness. Secondly, it is critically important that hazardous facilities include non-monetary costs (e.g., externalities and common resources) as part of their analysis. In other words, operators of potentially hazardous facilities cannot be solely motivated by short-term profits, but rather must have an ongoing concern for the well-being of the community(ies) in which they locate. In short they cannot exploit the environment, the community or its people for company profit.

And third, the responsibility for safety must be shared between the company and the people. Nearby residents must care enough to actively participate in meaningful ways. This includes raising community concerns for discussion, listening and constructively responding to potential alternatives, and contributing to a process by which agreeable solutions are reached. Moreover, no matter how effective the company and community emergency plans, ultimately they are only as effective as the public's response. Hence, the public must share in the responsibility for effective emergency response. The companies operating potentially hazardous facilities, the communities preparing for potential emergencies, the regulatory agencies guiding these processes, and the public must all recognize this shared responsibility for safety.

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