The Determinants of Trust and Credibility in Environmental Risk Communication:

An Empirical Study

[Abbreviated Title: A Study of Trust and Credibility Factors]

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Abstract

This study examines a key component of environmental risk communication: trust and credibility. The study was conducted in two parts. In the first part, six hypotheses regarding the perceptions and determinants of trust and credibility were tested against survey data. The hypotheses were supported by the data. The most important hypothesis was that perceptions of trust and credibility are dependent on three factors: perceptions of knowledge and expertise; perceptions of openness and honesty; and perceptions of concern and care. In the second part, models were constructed with perceptions of trust and credibility as the dependent variable. The goal was to examine the data for findings with direct policy implications. One such finding was that defying a negative stereotype is key to improving perceptions of trust and credibility.

Introduction

The modern age of environmental risk communication in the United States, with its focus on health and environmental issues, can be traced to the second term of William Ruckelshaus as EPA Administrator. At the beginning of his second term, Ruckelshaus invoked the Jeffersonian goals of informing and involving the public as foundation principles in environmental risk management[1]. Since that time, these goals have been echoed in far-reaching right-to-know legislation, most notably the Superfund Amendments and Reauthorization Act's public participation provision and the community right-to-know requirements of the Emergency Planning and Community Right-To-Know Act of 1986. In a period of barely ten years, environmental risk communication has evolved from a management concept to codified legislation.

In parallel with the growth of environmental risk communication legislation, there has been a long-term decline in public confidence and trust in traditional social institutions, especially government and industry. Survey data indicate that ratings of confidence in government and industry have severely eroded during the past thirty years[2-4].

Corresponding to the decline in institutional credibility has been the rise of citizen environmental groups. Laird[5] has argued that the dramatic growth of these groups since the 1970's is a natural accompaniment to the decline of public confidence in traditional institutions. A major institutional shift in society has occurred. As public trust in institutions has declined, public trust in citizen groups has increased.

Given the importance of trust and credibility in environmental decision making, a fundamental question remains unanswered: What factors determine trust and credibility? This question is the focus of the current study. More specifically, it is the hypothesis of this study that trust and credibility are based on three determinants: knowledge and expertise; openness and honesty; and concern and care.

These determinants of trust and credibility were first suggested by Aristotle[6] over two thousand years ago. These three determinants can also be found in the writings of several more recent authors. Kasperson[7] for example, has argued that trust is composed of percep-

tions of competence, of absence of bias, and of caring and a commitment to due process. More recently, Kasperson, Golding and Tuler[8] expanded this list and identified four components of trust: (1) commitment to a goal (for example, to the protection of public health) and fulfilling fiduciary responsibilities; (2) competence; (3) caring; and (4) predictability. The authors argue that perceptions of commitment to a goal are in turn based on perceptions of objectivity, fairness, and information accuracy. Commitment to a goal, fulfilling fiduciary responsibilities, and caring can all be understood as a means to demonstrate concern and care for others[9]. The three factors upon which perceptions of commitment are based, perceptions of objectivity, fairness and information accuracy, can all be understood as indicators of openness and honesty. Competence and predictability can be understood as factors relating to knowledge and expertise.

Renn and Levine[10] have also proposed a set of components that determine perceptions of trust and credibility. Their set consists of five attributes: (1) competence; (2) objectivity; (3) fairness; (4) consistency; and (5) faith (defined by the authors as goodwill). This set of components can also be related to three basic credibility determinants. In this case, competence corresponds with knowledge and expertise; objectivity and fairness with openness and honesty; and consistency and faith (goodwill) with concern and care for others in the short and long term. Covello[11,12] has offered a set of four factors that determine perceptions of trust and credibility. These factors are perceptions of: (1) caring and empathy; (2) dedication and commitment; (3) competence and expertise; and (4) honesty and openness. The correspondence of Covello's first factor with concern and care for others is self evident. Dedication and commitment can also be related to concern and care in that they represent a natural extension of concern and care, i.e., to care so much that one is willing to go above and beyond. The correspondence between the remaining two sets of factors -- knowledge and expertise, and openness and honesty -- is also self-evident.

Given the general recognition of the importance of trust and credibility in effective risk management, and given that none of the current theories relating to trust and credibility have been empirically tested, the primary goal of the present study is to conduct an empirical analysis of perceptions of trust and credibility as they relate to environmental risk communication. The

second goal of the study is to answer the question: What factors determine trust and credibility in environmental decision making?

The study was conducted in two parts: (1) hypothesis testing; and (2) model construction.

Section 1: Hypothesis Testing

1.1 Introduction.

In total, six hypotheses were tested.

1.1.1 Hypotheses 1 and 2. The first two hypotheses, based on the earlier discussion of the literature on trust and credibility, are:

Hypothesis One: Perceptions of trust and credibility are dependent on three factors: perceptions of knowledge and expertise; perceptions of openness and honesty; and perceptions of concern and care.

Hypothesis Two: Commitment on the part of a communication source is perceived as a display of concern, and the two are strongly related.

1.1.2 Hypothesis 3. As a corollary to the hypothesis that perceptions of openness and honesty are determinants of trust and credibility, it can be hypothesized that activities that indicate active disclosure of information will increase the trust afforded to groups performing such activities. These activities may be in the form of community notification regarding the use, storage or release of toxic agents; the preparation of contingency plans to respond to the unintentional release of hazardous materials; or the education and follow-up training of police or fire department personnel to respond to environmental emergencies. Therefore, it is proposed that as public disclosure activities undertaken by traditional institutions increase, the trust afforded such institutions would also increase. Accordingly, the third hypothesis is:

Hypothesis Three: Acts of public disclosure of risk management activities by local businesses and government is strongly related to trust and credibility of industry and government, with higher levels of activity corresponding with higher trust and credibility.

1.1.3 Hypothesis 4. Another corollary to the hypothesis that perceptions of openness and honesty are determinants of trust and credibility proposes that activities that enhance perceptions of openness and honesty will increase trust and credibility. Providing environmental risk information is one such activity, as it demonstrates that the communication source is both forthcoming and forthright. However, it is not solely the provision of information that is important, but whether that information has been received; indeed, a message transmitted but not received has little value. Therefore, the fourth hypothesis is:

> Hypothesis Four: Perceptions of trust and credibility of a source will be strongly related to the amount of information received from the source.

1.1.4 Hypothesis 5. Douglas and Wildavsky[13] and Wildavsky and Drake[14] have proposed a cultural theory of risk perception in which individuals who view nature as fragile and who focus their attention on technological and environmental risks will be distrustful of traditional, hierarchical institutions and trustful of citizen groups, while those who instead focus their attention on other societal risks, such as war or the economy, will be trustful of traditional institutions and distrustful of citizen groups. A more traditional theory of risk perception is presented by Laird[5]. This theory holds that individuals focus on the risks that appear to most directly threaten their well being, and that the failure to control or correct such risks is a failure to fulfill a fiduciary responsibility, and, or, a failure to demonstrate competence. Such failure results in a decrease in the trust and credibility afforded the traditional institutions charged with controlling or mitigating the risk, and a corresponding increase in the trust and credibility afforded citizen groups. Whichever theory is correct, the relationship between risk perception and trust and credibility is the same: as the perception of environmental risks increases, the trust afforded traditional institutions should fall and the trust afforded activist citizen groups should rise. This leads to the fifth hypothesis:

> Hypothesis Five: Respondent's level of concern with environmental health risks will be positively related to trust and credibility of citizen groups and negatively related to trust and credibility of industry and government.

1.1.5 Hypothesis 6. Various authors have stated that accidents or mishaps are regarded by the public as signals or omens of further, and possibly worse, events[15-17]. Similarly, Covello[18] has noted that public attention is often focused on activities that have a history of accidents. In addition, the ability to recall such events has been shown to adversely affect judgements of the frequency and probability of the occurrence, and more recent occurrences are more likely to be recalled than those further in the past [19,20]. It is proposed that these factors will combine to create a temporal effect on risk perceptions, so that recent sensitization to risks will result in an increase in perceived risk, compared to less recent sensitization. This increase should affect the trust and credibility afforded traditional institutions and citizen groups through the mechanism presented in the discussion preceding Hypothesis Five above, with the result that recent accidents or mishaps should decrease the trust afforded traditional institutions and increase the trust afforded activist citizen groups to a greater extent than less recent events. This proposal is stated in the following hypothesis:

> Hypothesis Six: Sensitization to the risks of chemicals or hazardous wastes will affect trust and credibility, lowering the trust and credibility of industry and government, and raising the trust and credibility of citizen groups. Specifically, a temporal effect is proposed, such that respondents who recently received fear-arousing information regarding environmental risks will have lower trust of industry and government, and higher trust of citizen groups, than respondents who received such information further in the past.

1.2 Methodology

Data collection commenced with a survey of members of the general public to measure perceptions of trust and credibility and the hypothesized determinants with regard to industry, government, and citizen groups, operationalized as the chemical industry and business, the U.S. Environmental Protection Agency, and environmental groups, respectively. The majority of measurements were made using four-point, Likert-type scaling[21]. These responses were assigned numeric values on equal interval scales such that one was the highest positive rating and four was the lowest. Performing the survey in this way provided ordinal response categories and allows comparisons to be drawn between public perceptions of industry, of government, and of citizen groups.

The survey was nested within a larger survey conducted by researchers from the Center for Risk Communication of Columbia University as part of an ongoing study of public knowledge and perceptions of chemical risk in six communities[22]. Random digit dialing was used to select respondents. The overall response rate was 62%, defined as:

Response Rate = Number of Completed Interviews/

(Number in Sample - Number Not Eligible or Reachable).

This rate is consistent with those reported elsewhere for surveys of this type(23,24).

All survey respondents were adults, eighteen years of age or older, living in six communities: Albuquerque, New Mexico; Cincinnati, Ohio; Middlesex County, New Jersey; Racine County, Wisconsin; Raleigh/Durham, North Carolina; and Richmond, Virginia. The community composition of the respondents is presented in Table 1. The communities selected for the study satisfied the following criteria: (1) presence of significant industry that used, processed, stored, or released chemicals; (2) location of a hazardous waste site (Superfund or other); (3) existence of an active local environmental group; and (4) prior emission problems or enforcement activities[22]. The survey data cannot be extrapolated to all U.S. communities, nevertheless, this analysis will provide insights into the perceptions of randomly selected residents of these six communities, and this information may be applicable to other communities experiencing comparable events.

Due to the nature of the survey, subjects could respond "Don't know" in answer to some questions. In these cases, the frequency of such responses was tabulated. Following Babbie[25], if the frequency of such responses was less than 10%, these subjects were removed from that particular analysis. Only in testing Hypothesis Three was this limit exceeded; it was exceeded in eight of nine tests conducted in testing the hypothesis. The "Don't know" response rate was approximately 8% in three of the nine tests conducted for testing Hypothesis Five, and was below 3.6% for the other six tests. In testing the other hypotheses, the "Don't know" response rate ranged from less than 1% for the Hypothesis One testing to 4.2% for one of the three tests conducted in testing Hypothesis Two. In all cases where they were removed, the "Don't know" respondents were not significantly different from those included in the hypothesis testing in

the four Hypothesis One variables when a critical value of .0125 was used, consistent with a Bonferroni-type correction of .05/4 to control for Type I error. In addition, those who responded "Don't know" one or more times did not differ from complete responders on race or income.

As indicated above, the structure of the study required that more than one statistical test be performed in testing each individual hypothesis. This, in turn, required that the critical value used for significance testing be adjusted to control for Type I error. Accordingly, an adjustment was made to the critical value applied to each set of comparisons performed in the hypothesis testing, as recommended by Klein[26] and Rothman[27]. Specifically, a Bonferroni-type correction was made, wherein the critical value of 0.05 was divided by the number of a priori comparisons[28,29]). All tests were two-tailed.1.3 Results and Discussion

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1.3.1 Demographics. Prior to hypothesis testing an analysis of respondent and 1990 U.S. Census demographics was conducted[30]. This analysis found differences between the two populations in racial composition, educational attainment, and income level. The demographics of the survey respondents depict a population with a higher proportion of whites, a higher level of educational attainment, and a higher level of affluence than is reported in the Census. The effect of these demographic factors on perceptions of trust and credibility of industry, government, and citizen groups was analyzed. The demographic factors sex and age were included in the analysis, also. Of the fifteen statistical tests conducted, in only one case was the result statistically significant when a Bonferroni-type correction was made to control for Type I error. In this one case, a correlation was found to exist between income and trust in government. Accordingly, income was included as an independent variable in the model construction.

1.3.2 Hypothesis Testing

Testing of the first hypothesis entailed the construction of multiple linear regression models with perceptions of trust and credibility as the dependent variable and perceptions of knowledge and expertise, of openness and honesty, and of concern and care as the three independent variables. Model construction was preceded by an examination of the intercorrelation

among the independent variables. The largest correlation coefficient was .47, and the intercorrelation judged insufficient to introduce multicollinearity in the subsequent analyses.

Next, regression equations were fitted to the data. The equations all had the following form: *(Trust and Credibility) a = 0+1 (Knowledge and Expertise) a+ 2 (Openness and Honesty) a + 3 (Concern and Care) a +* where a = {industry, government, citizen groups}, and 0 is the random error term associated with linear regression. As can be seen in Table 2, in all cases the findings were statistically significant. The values of the coefficients of determination (R^2) were .20 for industry, .29 for government, and .39 for citizen groups, indicating that from 20% to nearly 40% of the variation in trust and credibility is accounted for, or explained by, the hypothesized determinants. Although this falls short of accounting for the full variance in the outcome variable, it indicates the underlying worth of the hypothesis in defining the factors that determine perceptions of trust and credibility. Also presented in Table 2 are the regression coefficients for the independent variables, along with their standard errors. The results strongly support the hypothesis that perceptions of knowledge and expertise, of openness and honesty, and of care and concern are determinants of trust and credibility.

The second hypothesis investigated the relationship between perceptions of commitment of a communication source and perceptions of the source's concern and care. As shown in Table 3, in all cases the trend was in the predicted direction, with perceptions of higher levels of commitment corresponding with perceptions of higher levels of concern and care. Correlation coefficients confirm the observed trend. The correlation coefficient for industry was .41, for government was .43, and for citizen groups was .39; all were statistically significant when a critical value of .0167 was used. These correlation coefficients display a strength and consistency that indicate a clear relationship between perceptions of commitment and perceptions of concern and care, and strongly support the hypothesis.

The third hypothesis proposed that as public knowledge of acts of disclosure of risk management activities undertaken by traditional institutions increases, the trust afforded such institutions will also increase because of the openness and honesty of such activities. In testing this hypothesis, the responses to five questions concerning the respondents' level of knowledge of acts

of public disclosure of local business and government, and the effect of such knowledge on perceptions of trust and credibility, were analyzed; four questions applied both to industry and to government, and one applied to government only. Responses to the four questions that applied to both industry and government were measured on nominal scales. These four questions inquired into the respondents' knowledge of emergency preparedness plans; knowledge of the presence of trained emergency response personnel; knowledge of a reduction in the use, storage or release of toxic materials by industry; and knowledge of the active disclosure of information regarding the use, storage or release of toxic materials by industry. The fifth question, which applied to government only, was a ranking of the perceived knowledge of the care that industry took with hazardous materials, and was measured on a four-point ordinal scale.

In all cases the trend was in the predicted direction, supporting the hypothesis. Respondents who answered positively to questions pertaining to their knowledge of disclosure activities of industry and government afforded these institutions higher trust and credibility than did respondents who answered negatively. Statistical significance was obtained in two of the nine tests conducted. In one of the two (Table 4-A), respondents who had knowledge of the active disclosure of information regarding the use, storage or release of toxic materials by industry had higher trust of industry than respondents who were certain they had no knowledge of such disclosure or who answered "Don't Know," and the analysis of variance conducted to test this difference found a strong statistical significance. In the second case (Table 4-B), respondents who had knowledge of a reduction in the industrial use, storage or release of toxic materials had higher trust of government than respondents who were certain they had no such knowledge or who answered "Don't Know." Here, the analysis of variance had weaker statistical significance. Visual inspection of the data indicates that the greatest differences exist between those who had answered "Yes" and those who had answered "No." Confirming these observations, Scheffe procedures found statistically significant differences between respondents who had knowledge of these activities and those who had no such knowledge.

The findings are reasonable. The former case, the disclosure of information, touches directly on the determinant openness and honesty. Further, such disclosure demonstrates not only industry's openness and honesty, but it is also a means of public empowerment. This additional factor is not present in the other activities under consideration, and may account for

the strong statistical significance of the effect of information disclosure on perceptions of trust and credibility. The latter case, the reduction in the use, storage or release of toxic materials, describes pro-active precautions and activities which would reduce the likelihood of an emergency, rather than re-active responses to an existing emergency, characterized by the training of response personnel and preparation of response plans. Such a pro-active nature may account for the higher statistical significance of the effect of this activity on trust and credibility and for the lack of significance of the other, reactive, activities studied.

In conclusion, limited but significant confirmation of the hypothesis was obtained.

The fourth hypothesis proposed that the amount of information receipt will affect perceptions of the trust and credibility of the communication source. To test this hypothesis, correlation coefficients were calculated to assess the effect of the amount of information received from a source on perceptions of trust and credibility of the source. Three correlation coefficients were determined, one each for industry, government, and citizen groups. As can be seen in Table 5, in all three cases the trends were in the predicted direction, with higher levels of receipt of information corresponding with higher levels of trust. The sign of the correlation coefficients confirms the observed trend. The correlation coefficient was .32 for industry, .23 for government, and .30 for citizen groups; all were statistically significant. The size and statistical significance of the correlation coefficients support the hypothesis that perceptions of trust of a source are strongly related to the amount of information received from the source.

In relation to this finding, it should be noted that trust and credibility are also likely to be related to the meaningfulness of the information, which is not necessarily related to the amount. Given the importance of this additional dimension of information, future studies should be designed to test this hypothesis against empirical data.

The fifth hypothesis proposed a relationship between perceptions of risk and perceptions of trust and credibility, such that as the perception of environmental risks increases, the trust afforded traditional institutions will fall and the trust afforded activist citizen groups will rise. The responses to three questions ascertaining the respondents' level of concern with environmental health risks were analyzed. One question asked respondents to compare their community's environmental health risks to other areas, a second question inquired into the

perceived presence of facilities or locations in the area that posed a threat to environmental safety, and a third asked respondents to rank the risk of chemicals produced, processed or stored in the community against other health and safety risks, offering as examples automobile accidents, food-borne illness, heart disease, and home fires. Responses to the first two questions were measured on nominal scales; responses to the third question were measured on a five-point, ordinal scale, ranging from "not a problem" to "a very serious problem." In total nine statistical tests were conducted.

The data were inspected for trends, and the strength of the effect was tested for statistical significance. In most cases the trend was in the expected direction, and in three cases was statistically significant.

The effect was statistically significant for two of the industry questions. One was the question regarding the presence of threatening facilities or locations (Table 6-A). The other was the comparative, risk ranking. These data displayed the expected trend over the first four scale points but showed a reversal at the fifth point (Table 6-B). The reversal could be due to several factors, including the respondent's failure to fully understand the question, data entry error, or a flaw in the hypothesis. Given the small number of respondents in this group -- thirteen out of 391, or 3% -- this issue can only be resolved with a larger sample size. The association between this response set and perceptions of trust and credibility afforded industry had a statistically significant correlation coefficient of .19.

Turning next to the data pertaining to trust and credibility of government, as with the industry data, the effect was statistically significant for the question regarding threatening facilities or locations (Table 6-C).

The data on citizen groups were not statistically significant. Overall, the data provide partial support of the hypothesis, with the data on industry offering the strongest support.

The sixth hypothesis proposed a temporal effect on risk perceptions, such that more recent sensitization to risks will result in an increase in perceived risk, and that this increase should affect the trust and credibility afforded traditional institutions and citizen groups, with the result that recent accidents or mishaps should decrease the trust afforded traditional

institutions and increase the trust afforded activist citizen groups to a greater extent than would less recent events. To test this hypothesis, an ordinal variable was constructed. This variable could take on one of three values: sensitization during the week immediately prior to the survey; sensitization during the three months prior to the survey, but not during the past week; or sensitization more than three months prior to the survey.

As shown in Tables 7-A and 7-B, the trends in the data were as predicted for industry and for government, with more recent sensitization associated with lower trust. The correlation coefficient was -.15 for the industry data set, and was statistically significant. The correlation coefficient was -.101 for the government data set; however, the association was not statistically significant. The trend in the data set for citizen groups was not as predicted; indeed, no trend was evident.

All respondents who had received fear-arousing information during the three months prior to the survey were asked to identify the event. In an effort to determine if one large, isolated event underlay the response sets, these data were analyzed both to determine the most common events and to determine if all responses were originating from one of the six survey communities. Consistent with the format used above, this analysis was conducted for each organization. In all three cases, the top event cited by respondents was general water pollution, followed by contamination from sewage treatment and accidental chemical leak or discharge. These three events were then cross-tabulated against each of the six survey communities. Although the resulting cell sizes were small, no dramatic clustering was observed, indicating that the response sets reflected general perceptions and were not influenced by a single, isolated event.

In conclusion, the hypothesis found only partial support in the data; the expected trends were observed in two of the three cases and the data for industry offered the only statistically significant support.

Section 2: Modeling

The goal of the second part of the study was to further examine the data for findings that have direct policy implications. Consequently, the results of the Section I hypothesis

testing were combined into three multiple linear regression models, one each for industry, for government, and for citizen groups. The three resulting summary equations were developed with perceptions of trust and credibility as the dependent variable and the statistically significant findings from the hypothesis testing and a demographic analysis as the independent variables.

2.1 Methodology

The derivation, methodology and testing of the hypotheses are presented in the previous section. The analysis presented in this section employed SPSS/PC+ V3.1[31] software to develop three summary equations. The equations were constructed using the available forward selection, backward elimination, and stepwise selection regression modeling procedures.[1]

2.2 Results and Discussion

The construction of the summary equations began with selection of the independent variables. Model construction was preceded by an examination of the intercorrelation among the independent variables. None were greater than .45, and were judged insufficient to introduce multicollinearity in the subsequent analysis.

Industry For perceptions of trust and credibility of industry nine independent variables were selected, presented in Table 8-A.

Regression equations were fitted to the data. All three selection procedures yielded the same equation, presented in Table 9-A. The equation had a coefficient of determination (R 2) of .30, which was statistically significant. This coefficient indicates that 30% of the variation in industry trust and credibility is explained by the independent variables, a relative increase of 50% above the equation presented in Section I. Comparing the summary equation with the Section I equation, the leading explanatory variable for perceptions of industry trust and credibility remains perceptions of concern and care which, when modeled alone, accounted for 17% of the variation in the dependent variable. In the summary equation, perceptions of concern and care are closely followed by the level of information received from the source and by perceived knowledge of active disclosure of information, and more distantly by perceptions of openness and honesty and by media sensitization. This last term has a negative coefficient,

consistent with the inverse relationship found earlier between media sensitization and perceptions of industry trust and credibility.

The model indicates that an increase in public perceptions of concern and care on the part of industry will result in a larger increase in perceptions of trust and credibility than an equal increase in any other independent variable under consideration. Furthermore, the strength of the coefficients of the next two variables -- i.e., level of information received, and active disclosure of information -- indicate that there are multiple avenues for raising industry trust and credibility.

Government Turning next to the summary equation for perceptions of trust and credibility of government, eight independent variables were selected, presented in Table 8-B.

Regression equations were fitted to the data. All three selection procedures yielded the same equation presented in Table 9-B. The equation had a coefficient of determination (R 2) of .40, which was statistically significant. This coefficient indicates that 40% of the variation in government trust and credibility is explained by the independent variables, a relative increase of 28% above the Section I equation. Reviewing the summary equation, the leading explanatory variable for perceptions of government trust and credibility is commitment which, when modeled alone, accounted for 26% of the variation in the dependent variable. Perceptions of commitment are closely followed by the perceptions of knowledge and expertise, then by perceptions of concern and care, and more distantly by income and by the level of information received from the source. The next-to-last term has a negative coefficient, consistent with the inverse relationship found earlier between income and perceptions of government trust and credibility. The results are consistent with the Section I equation, in which perceptions of knowledge and expertise was the leading explanatory variable, followed by perceptions of concern and care and, more distantly, by perceptions of openness and honesty. In the summary equation the latter term has been dropped, perceptions of commitment have supplanted those of knowledge and expertise, and income and information receipt have been added.

The model indicates that an increase in public perceptions of commitment on the part of government will result in a larger increase in perceptions of trust and credibility than an equal increase in any other independent variable under consideration. Furthermore, the strength of

the coefficient of the next variable, perceptions of knowledge and expertise, indicate that there is another important avenue for raising government trust and credibility.

Citizen Groups Turning last to the summary equation for perceptions of trust and credibility of citizen groups, five independent variables were selected, presented in Table 8-C.

Regression equations were fitted to the data. All three selection procedures yielded the same equation, presented in Table 9-C. The equation had a coefficient of determination (R 2) of .43, which was statistically significant. This coefficient indicates that 43% of the variation in trust and credibility is explained by the independent variables, a relative increase of 10% above the Section I equation.

Comparing the summary equation with the Section I equation, the leading explanatory variable for perceptions of citizen groups trust and credibility remains perceptions of knowledge and expertise which, when modeled alone, accounted for 36% of the variation in the dependent variable. As can be seen in Table 9-C, perceptions of knowledge and expertise are followed by perceptions of commitment, by the level of information received from the source and, distantly, by perceptions of openness and honesty.

The model indicates that an increase in public perceptions of knowledge and expertise on the part of citizen groups will result in a larger increase in perceptions of trust and credibility than an equal increase in any other independent variable under consideration. In fact, the strength of the coefficient for this variable argues that this variable alone offers a uniquely profitable avenue for raising citizen groups trust and credibility.

Conclusion

The analysis in Section I examined perceptions of trust and credibility and the determinants and factors associated with variations in such perceptions. As discussed earlier, several theories have been postulated regarding determinants of perceptions of trust and credibility in environmental risk communication, but none has been tested. The present study tested a hypothesized set of determinants of perceptions of trust and credibility in environmental risk communication. In addition, the study tested several hypotheses related to factors causing variations in such perceptions.

In total, six hypotheses were tested in Section I against survey data to determine their validity. The six hypotheses found varying levels of support in the data. Strong support was found for the first hypothesis, which proposed a set of three determinants of trust and credibility. Testing of this hypothesis found that these three determinants -- knowledge and expertise, honesty and openness, and concern and care -- accounted for a significant amount of the variation in perceptions of trust and credibility. Strong support was also found for two other hypotheses: the second, which proposed a strong relationship between perceptions of commitment and of honesty and openness; and the fourth, which proposed that activities that enhance perceptions of openness and honesty would increase trust and credibility. Moderate support was found for two hypotheses: the third, which proposed that activities that enhance perceptions of concern and care would increase the trust afforded to groups performing such activities; and the fifth, which proposed that increased perceptions of environmental risk will decrease the trust afforded traditional institutions and increase the trust afforded citizen groups. Weak support was found for the sixth hypothesis, which proposed a temporal effect of sensitization on risk perception.

The analysis in Section II extended and expanded the results of the previous analysis. Specifically, summary equations were constructed combining the results of the previous findings into three multiple linear regression models, one each for industry, for government, and for citizen groups. The three equations were developed with perceptions of trust and credibility as the dependent variable and the statistically significant findings from the hypothesis testing as the independent variables.

The summary equations produced the following results:

1) For industry, an increase in public perceptions of concern and care results in a larger increase in perceptions of trust and credibility than any other variable under consideration.

2) For government, an increase in public perceptions of commitment results in a larger increase in perceptions of trust and credibility than any other variable under consideration.

3) For citizen groups, an increase in public perceptions of knowledge and expertise results in a larger increase in perceptions of trust and credibility than any other variable under consideration.

4) For society as a whole, the determinants of trust and credibility are not monolithically invariant across organizations and institutions.

The research finds that the determinants of trust and credibility display considerable differences. Indeed, the three equations show a high degree of diversity. This diversity is evidenced in the range of the coefficients of determination. Not only did the strength of the determinants, and frequently the determinants themselves, differ from one equation to another, but the ability of the determinants to explain the variation in the dependent variable also displayed a range.

One explanation for the variation in the coefficients of determination of the regression equations can be found in commonly held stereotypes. Of the three organizations studied, citizen groups are most often drawn from the general public, and, as such, according to a common stereotype, are perceived to lack specialized knowledge of public health and safety issues. Support for this can be seen in Table 10-A, where the survey respondents' perceptions of knowledge and expertise are presented. As shown in the table, citizen groups are rated below both industry and government on this variable. Yet such perceptions are the strongest predictor of citizen groups trust and credibility. Similarly, industry, according to a common stereotype, is commonly perceived to care and be concerned only about profits, and minimally about public health and safety. Support for this can be seen in Table 10-B, where the survey respondents' perceptions of concern and care are presented. As shown in the table, industry is rated below both government and citizen groups on this variable. Yet perceptions of concern and care are the strongest predictor of industry trust and credibility. Thus, it appears that defying a negative stereotype is key to improving perceptions of trust and credibility.

The responses of the Johnson and Johnson Company to the Tylenol tampering incident in 1982, and of the Natural Resources Defense Council to the agricultural use of Alar in 1989 provide informative case studies[32,33]. In the tampering case, Johnson and Johnson defied the corporate stereotype, responding aggressively to protect the public health and safety by removing all its Tylenol product from the retail shelves. The recall cost the company $100 million, but it gained public trust and credibility which helped it regain market share and limit further losses. In the case of Alar, the Natural Resources Defense Council defied the citizen groups' stereotype, gaining public trust and credibility by preparing a detailed scientific study of the increased lifetime cancer risk arising from childhood exposure to pesticide residues in

fruits and vegetables. The study was an integral part of efforts by the Natural Resources Defense Council to lower permissible standards for such residues. These efforts focused on the chemical Alar, and led the manufacturer of Alar to withdraw the product from the market three months after the risk assessment was released.

These cases are consistent with a major finding of this analysis, i.e., that defying a negative stereotype is key to improving perceptions of trust and credibility. These cases also present the need for a broader set of case studies and for the collection of additional survey data to allow for more detailed examination of the issues raised in this article.

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Footnotes

1. In the forward selection procedure, the independent variables were sequentially added to the equation. Each variable was considered for entry into the equation based upon its correlation with the dependent variable. The first variable considered for entry was the one with the largest correlation. After the variable was selected, an F-statistic for the hypothesis that the coefficient for the variable is zero was calculated. The variable was entered into the equation if the significance of the F-statistic was no greater than .05. This process was reversed in backward selection, which started with all variables in the equation and sequentially removed them. Here, the first variable considered for removal was the one with the smallest partial correlation coefficient with the dependent variable. After the variable was selected, its F-statistic was examined. The variable was removed from the equation if the significance of the F-statistic was greater than .05. Stepwise selection is a combination of these two procedures. Variables were entered into the equation as in forward selection, based upon their correlation coefficients and F-statistics. However, after each variable was entered the variables in the resulting equation were examined for removal, as in backward selection. This process was continued until no variables remained that met the entry and removal criteria. These criteria were set at .05 and .10, respectively, to prevent the same variable from being repeatedly entered and removed.

The Determinants of Trust and Credibility in Environmental Risk Communication:

An Empirical Study

[Abbreviated Title: A Study of Trust and Credibility Factors]

Tables

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Table 1
Community Composition of Respondents

Community	Industry	Government	Citizen Groups
Albuquerque	97	97	101
Cincinnati	46	45	44
Middlesex Cty	38	33	36
Racine Cty	96	93	94
Raleigh/Durham	68	62	63
Richmond	59	55	55
Total	404	384	393

Table 2
Multiple Linear Regression
Dependent Variable: Trust and Credibility

	Industry	Government	Citizen Groups
Multiple R	0.450	0.535	0.623
R Square	0.203	0.286	0.389
F (3, 400)	33.891	50.860	82.420
Significance (p)	<.0001	<.0001	<.0001

	Industry		**Government**		**Citizen Groups**	
Independent Variable	Estimate of β ($\hat{\beta}$)	Standard Error of $\hat{\beta}$	Estimate of β ($\hat{\beta}$)	Standard Error of $\hat{\beta}$	Estimate of β ($\hat{\beta}$)	Standard Error of $\hat{\beta}$
Concern and Care	.415****	.051	.333****	.042	.116*	.038
Openness and Honesty	.169***	.048	.131**	.059	.113**	.057
Knowledge and Expertise	.028	.052	.423****	.050	.688****	.058
Constant	1.436	.183	.507	.147	.498	.115

Significance of t-test for parameter estimate:
(Industry df = 402; Government df=382; Citizen Groups df=402)

* .01 < p < .05
** .001 < p < .01
*** .0001 < p < .001
**** p < .0001

Table 3
Association of Perceptions of Concern and Care and Perceptions of Commitment

A. Summary of Concern and Care by Level of Commitment - Industry

Level of Commitment	Mean (Std. Dev.)	Cases (387)
High	1.714 (1.254)	7
Medium High	1.912 (0.746)	102
Medium Low	2.289 (0.683)	201
Low	2.896 (0.836)	77

Correlation Coefficient = .410, t = 8.818, p < .001, df = 385

B. Summary of Concern and Care by Level of Commitment - Government

Level of Commitment	Mean (Std. Dev.)	Cases (378)
High	1.250 (0.762)	32
Medium High	1.675 (0.693)	163
Medium Low	2.052 (0.686)	153
Low	2.767 (1.104)	30

Correlation Coefficient = .428, t = 9.177, p < .001, df = 376

C. Summary of Concern and Care by Level of Commitment - Citizen Groups

Level of Commitment	Mean (Std. Dev.)	Cases (384)
High	1.208 (.415)	24
Medium High	1.440 (.590)	200
Medium Low	1.699 (.707)	133
Low	2.556 (.934)	27

Correlation Coefficient = .383, t = 8.112, p < .001, df = 382

Table 4
Effect of Perceived Knowledge of Disclosure of
Risk Management Activities on Perceptions of Trust and Credibility

A. Summary of Trust and Credibility of Industry by Knowledge of Active Disclosure of Information

Level of Knowledge	Mean (Std. Dev.)	Cases (404)
Yes	2.547 (.896)	95
No	3.099 (.870)	223
Don't Know	2.954 (.839)	86

Analysis of Variance
$F(2, 401) = 13.407,\ p < .0001$

B. Summary of Trust and Credibility of Government by Knowledge of Reduced Use, Storage or Release of Toxic Materials

Level of Knowledge	Mean (Std. Dev.)	Cases (384)
Yes	1.991 (.840)	225
No	2.316 (.925)	114
Don't Know	2.133 (.869)	45

Analysis of Variance
$F(2, 381) = 5.308,\ p = .0053$

Table 5
Effect of Level of Information Received from a Source on
Perceptions of Trust and Credibility of the Source

A. Summary of Trust and Credibility of Industry by Level of Information Received

Level of Information	Mean (Std. Dev.)	Cases (400)
A Lot	2.286 (.995)	14
Some	2.413 (.796)	63
Not Too Much	2.932 (.737)	118
No Information	3.166 (.909)	205

Correlation Coefficient = .319, $t = 6.705$, $p < .001$, $df = 398$

B. Summary of Trust and Credibility of Government by Level of Information Received

Level of Information	Mean (Std. Dev.)	Cases (376)
A Lot	1.629 (.808)	35
Some	1.964 (.787)	138
Not Too Much	2.279 (.835)	86
No Information	2.299 (.976)	117

Correlation Coefficient = .229, $t = 4.551$, $p < .001$, $df = 374$

C. Summary of Trust and Credibility of Citizen Groups by Level of Information Received

Level of Information	Mean (Std. Dev.)	Cases (390)
A Lot	1.677 (0.919)	62
Some	1.886 (0.732)	176
Not Too Much	2.305 (0.815)	59
No Information	2.430 (1.077)	93

Correlation Coefficient = .303, $t = 6.262$, $p < .001$, $df = 388$

Table 6
Effect of Concern with Environmental Health Risks on
Perceptions of Trust and Credibility

A. Summary of Trust and Credibility of Industry by Perceived Presence of Facilities or Locations Posing Environmental Health Threat

Facilities or Location Present	Mean (Std. Dev.)	Cases (392)
Yes	3.066 (.852)	197
No	2.774 (.920)	195

$t = 3.258$, $p = .001$, $df = 390$

B. Summary of Trust and Credibility of Industry by Comparative Ranking of Environmental Health Risk

Level of Risk	Mean (Std. Dev.)	Cases (391)
None	2.671 (0.906)	88
Minor	2.882 (0.888)	153
Slightly Serious	3.010 (0.851)	99
Serious	3.421 (0.683)	38
Very Serious	2.923 (1.188)	13

Correlation Coefficient = .192, $t = 3.848$, $p < .001$, $df = 389$

C. Summary of Trust and Credibility of Government by Perceived Presence of Facilities or Locations Posing Environmental Health Threat

Facilities or Location Present	Mean (Std. Dev.)	Cases (370)
Yes	2.235 (.881)	179
No	1.979 (.870)	191

$t = 2.805$, $p = .005$, $df = 368$

Table 7
Effect of Media Sensitization on Perceptions of Trust and Credibility

A. Summary of Trust and Credibility of Industry by Media Sensitization

Recency of Sensitization	Mean (Std. Dev.)	Cases (396)
< 1 Week	3.189 (.786)	53
> 1 Week, < 3 Months	3.028 (.866)	109
> 3 Months	2.833 (.918)	234

Correlation Coefficient = -.146, t = 2.930, p = .0036, df = 394

B. Summary of Trust and Credibility of Government by Media Sensitization

Recency of Sensitization	Mean (Std. Dev.)	Cases (380)
< 1 Week	2.375 (.959)	48
> 1 Week, < 3 Months	2.093 (.849)	108
> 3 Months	2.058 (.874)	224

Correlation Coefficient = -.101, t = 1.979, p = .0485, df = 378

Table 8
Summary Equation Variables

A. Industry

Hypothesis	Variable Name
I	Concern and Care
I	Openness and Honesty
I	Knowledge and Expertise
II	Commitment
III	Information Disclosure
IV	Information Receipt
V	Comparative Risk Ranking
V	Threatening Facilities
VI	Media Sensitization

B. Government

Hypothesis	Variable Name
I	Concern and Care
I	Openness and Honesty
I	Knowledge and Expertise
II	Commitment
III	Reduced Industrial Use, Storage, or Release of Toxics
IV	Information Receipt
V	Threatening Facilities
Pre-testing	Income

C. Citizen Groups

Hypothesis	Variable Name
I	Concern and Care
I	Openness and Honesty
I	Knowledge and Expertise
II	Commitment
IV	Information Receipt

Table 9
Multiple Linear Regression - Forward, Backward and Stepwise Selection
Summary Equation
Dependent Variable: Trust and Credibility

	Industry	Government	Citizen Groups
Multiple R	0.55	.630	.659
R Square	0.303	.397	.434
F (5, 348)	30.244	45.521	72.214
Significance (p)	<.0001	<.0001	<.0001

A. Industry

Independent Variable	Estimate of B ($\hat{\beta}$)	Standard Error of $\hat{\beta}$
Concern and Care	.325****	.052
Information Receipt	.286****	.050
Information Disclosure	.288**	.098
Openness and Honesty	.127**	.048
Media Sensitization	-.139*	.056
Constant	.328	

B. Government

Independent Variable	Estimate of B ($\hat{\beta}$)	Standard Error of $\hat{\beta}$
Commitment	.382****	.055
Knowledge and Expertise	.352****	.058
Concern and Care	.198***	.052
Income	-.086*	.035
Information Receipt	.080*	.038
Constant	.274	.196

Table 9
Multiple Linear Regression - Forward, Backward and Stepwise Selection
Summary Equation
Dependent Variable: Trust and Credibility

C. Citizen Groups

Independent Variable	Estimate of B ($\hat{\beta}$)	Standard Error of $\hat{\beta}$
Knowledge and Expertise	.615****	.054
Commitment	.251****	.053
Information Receipt	.120**	.036
Openness and Honesty	.093*	.037
Constant	-.064	.149

Significance of t-test for parameter estimate:
(Industry df = 352; Government df = 350; Citizen Groups df = 352)

* $.01 \leq p < .05$

** $.001 \leq p < .01$

*** $.0001 \leq p < .001$

**** $p < .0001$

Table 10
Survey Mean Responses on Leading Independent Variables

A. Knowledge and Expertise

	Mean	Std. Dev.	Cases
Industry	1.488	.780	404
Government	1.560	.675	384
Citizen Groups	1.672	.715	393

B. Concern and Care

	Mean	Std. Dev.	Cases
Citizen Groups	1.595	.723	393
Government	1.878	.810	384
Industry	2.307	.818	404

Note: All measurements made on four point Likert-type scales, to which numeric values were assigned such that 1 was the highest rating and 4 was the lowest.