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Environmental Initiative Prioritization with a Delphi Approach: A Case Study

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ABSTRACT / India is fast finding its place in the industrialized world and that is beginning to raise its environmental consciousness. The Delphi technique was used to prioritize specific needs and articulate a sustainable urban improvement strategy for the city of Mumbai (formerly Bombay). The Delphi technique is a means of achieving consensual validity among raters by providing them feedback regarding other raters' responses. Mumbai has several indigenous environmental groups that were tapped for activists and leaders; the study was conducted using ten environmentalists. In the initial phases the responses resulted in a range of possible program alternatives. The last two stages helped to seek out information that generated a consensus on the part of the respondent group. Statistical analysis methods included a hierarchical cluster analysis, mean, median, mode, and percent of agreement calculations using SPSS software. The face-to-face discussion in phase 4 clarified some issues and helped the group as a whole to outline the strategy for putting in place the essential elements of a framework to improve the quality of life in an urban environment.

Environmental problems in developing countries increasingly threaten the economic and political interests of the world at large (Agarwal 1997). Environment and population are intimately connected in India, which has one billion people, adds 18 million new citizens every year, and is on track to succeed China as the world's most populous country by 2030 (Motavalli 2000). According to Tripathi and Tiwari (1996), population growth and its implication for the society and economy have been the main concerns of discussions at national as well as international levels. It is unanimously accepted that rapid population growth has been a major impediment on the path of development of India. As population increases, its pressure on natural and socioeconomic resources increases proportionately.

Urbanization is an inevitable and natural outcome of human population growth (Madsen 1998). When urbanization results from rapid migration in response to perceptions of economic opportunity, it frequently takes the character of "too much, too fast" (Hattangadi and Rubin 1995). Impacts of urbanization on the environment are numerous. Industrialization in India has resulted in excessive exploitation of natural resources, especially in urban areas (Bryjak 1984). The environmental problems result mainly from discharges into the air, water, and soil and from excess use of lands unsuitable for settlement (Blake 1998, Gray and Mearns 1989).

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The health impacts of environmental pollution are substantial and far more costly (Kothari 1997). In addition to losses in work-years and labor capacity, chronic illnesses reduce productivity at all ages and hinder the physical and mental development of the next generation (Goonesakere 1998). These impacts also imply costly social effects, which will undermine the nation's human resources development in the medium and long term. A healthy, balanced environment is as much a precondition for development as any comparative economic advantage (Ali and Sirivardana 1996).

The concentration of people in urban areas simultaneously increases both the concentration of pollution from human and economic activity and the number of people exposed to the health effects of that pollution, with the urban poor least able to protect themselves (Livernash and Rodenburg 1998). Improvements in urban environmental quality involve a long lead time, and the rapid growth of the industrial sector means that further delay will increase the costs as well as the risks (Siddiqi 1995).

Background Information

Although there are four major cities in India: Calcutta, Chennai, Mumbai, and New Delhi, Mumbai (formerly Bombay) has risen as the premier commercial, industrial, and transportation urban area (Richman 1994). The island city of Mumbai lies off the west coast of India just south of the Tropic of Cancer. The seven islands of Mumbai were joined together into one land-

mass through three centuries of reclamation. This one island is now 436 sq km in area (approximately 170 sq mi) and is connected to the mainland by several bridges. As a new millennium begins, the city is spreading over these bridges into the mainland. Because of the harbor, a wide bay between the city and the mainland, Mumbai has been a natural shipping and trading center through all of its short history. The position of the city ensures a uniform warm temperature throughout the year with the main climatic variation provided by the monsoons.

The 1991 census found that 12.5 million people lived in the Mumbai Metropolitan Region (Tripathi and Tiwari 1996). Of these, 9.9 million lived in Greater Mumbai. Estimates of the present population are in the range of 14–15 million. Mumbai's population has grown most rapidly in the years after India's independence (Feeney 1999). In the decade between the censuses of 1981 and 1991, there have been some signs of a leveling off in the growth.

Concomitant with the high rate of population growth within the greater Mumbai region was an explosive growth in retail, industrial, commercial, and transportation services (Stephen 1998). This has resulted in tremendous land-cover change dynamics within the metropolitan region, wherein urbanization has consumed vast acreage of land adjacent to the city proper and has pushed the rural/urban fringe farther and farther away from the original urban core (Hattangadi and Rubin 1995). An enormous transition of land from forest and agriculture to urban land uses has occurred in the last 25 years, along with subsequent changes in the land-atmosphere energy balance relationships (Kothari 1997).

According to a study by Kumar and others (2000), more than 5000 metric tons of solid waste is generated every day in Mumbai. The Municipal Corporation of Greater Mumbai (MCGM) is in charge of the disposal of this waste and evidently cannot cope with the task. The city generates about 2000 million liters per day of sewage, and discharges it into the adjoining west coast and the two creeks in the Arabian Sea. This has resulted in degradation of coastal water quality, and contamination of the adjoining beaches and seafronts. The MCGM has, therefore, undertaken the task of delineating an appropriate sewage disposal system to achieve a cleaner marine ecosystem at specific locations.

A recent study by the Environmental Pollution Research Center (EPRC) found that among Mumbai's major health problems, chronic respiratory problems due to air pollution are endemic among a large fraction of the population (Carpenter 1999). The main causes of air pollution are industries in the eastern suburbs and New Mumbai, garbage burning by the MCGM, and insufficient control over emission levels from vehicles (Sharma 1999). A study by Kulkarni and Patil (1999) demonstrates that the health risk to outdoor workers in an urban area is significantly more serious than that indicated by ambient air quality data because the health risk is directly related to the daily integrated exposure. Unless pollution control measures are enforced, the quality of life of many urban residents will continue to decline (Richman 1994).

The Mumbai environment protection lobby, which includes NGOs and community leaders, has been active and vigilant almost from the time the degradation began (Agarwal 1997). The environmental action groups have been doggedly protecting trees and open spaces, promoting vermiculture, cleaning beaches, and fighting for ecofriendly legislation, in the face of stiff opposition from industry. With limited financial and other resources, the activists will not be able to take on every environmental issue with the same degree of urgency. The establishment of priorities, therefore, should be based on a careful assessment of the costs and benefits involved. This study was designed to help the environmentalists develop alternative solutions to the region's environmental problems and feasible strategies to implement them.

Purpose of the Study

The purpose of this study was to prioritize the needs, evaluate options, and develop strategies to improve the urban environment, by using the Delphi study technique. The study was limited to Mumbai, India.

Methodology

Population and Sample

The population for this study consisted of environmental activists in the city of Mumbai. The first step was to establish contact with different environmental agencies in the city and identify activists and local government officials that are vigilant and able to provide leadership to improve the urban environment. In addition to community activists and local government officials, the author made contact with the following organizations: Bombay Environmental Action Group, Bombay Save Committee, MCGM, SOCLEEN Society, Center for Environmental Science and Engineering, and the US Asia Environmental Partnership. The author identified ten professionals who were invited to participate in the Delphi study. They consisted of widely respected community activists and leaders, high-

Table 1. Data on participants in the Delphi study

Criteria of Experts	A	B	C	D	E	F	G	H	I	J
Total years of practice/experience	20	15	12	11	21	18	14	16	11	17
Number of publications on the topic	55	42	19	18	33	19	31	24	15	41
Presentations at national conventions	29	19	10	12	32	18	19	22	26	54
Holds/held leadership/management positions in urban environmental organizations	X	X	X	X	X	X	X	X	X	X
Currently active in area of urban environment	X	X	X	X	X	X	X	X	X	X
Volunteered to participate	X	X	X	X	X	X	X	X	X	X

X = yes.

ranking local government officials, and directors, presidents, or board members representing the organizations listed above. The ten participants included two individuals from the private sector, four public officials, and four activists from NGOs. Table 1 provides data on the participants of this study and provides evidence that they met a variety of criteria. Thus it is assumed that this group represents leaders who are knowledgeable and committed to professionalism in the development and implementation of urban environmental policy reform.

Research Methods

The study was conducted during summer and fall 1999. The Delphi technique for a qualitative study was used to develop a range of possible program alternatives and seek out information that may generate a consensus on the part of the respondent group. The Delphi study technique is a means of achieving consensual validity among raters by providing them feedback regarding other raters' responses and, if possible, the reasons for such (Passig 1997). According to Linstone and Turoff (1995), a panel of raters independently completes a rating task; the results are then tabulated and returned to the panel members for rerating. The new results are tabulated, and the process continues until consensus or near consensus is achieved. As panel members work independently and are not in a group setting, group dynamics are not a factor. A study by Ono and Wedemeyer (1994) concluded that the Delphi technique is a valid technique for long-term forecasting.

Delphi items are typically broad-based and convergence of medians is effectively achieved in three or four rounds, after which it reaches the point of diminishing returns (Linstone and Turoff 1995). The role of the researcher is to act as a neutral facilitator when conducting a Delphi study. Much of the popularity and acceptance of Delphi rests on the claim of superiority of group over individual opinions, and the preferability of private opinion over face-to-face confrontation. On the other hand, numerous examples are cited where face-to-face discussions integrated with the Delphi technique clarified the issues and made honest communication possible (Katzenbach and Smith 1993).

This study used the anonymous setting in the first three phases to arrive at a meeting of the minds or consensus among the experts. In the final stage, there was a group discussion to facilitate greater insight into the issues.

Data Collection and Analysis

Once the participants were identified, there were four phases (three paper-and-pencil questionnaires and one group discussion) in which data was collected in response to a series of questions.

Phase I. The first questionnaire, which appears in Fig. 1, asked the participants to identify the top five urban environmental problems in India, especially in Mumbai and rate (on a scale of 1–5) the impact of each problem on the quality of life. Next, for each problem, the respondents were asked to design strategies to reduce the magnitude of those problems. The participants then rated each strategy on a scale of 1–5 regarding its chances for successful implementation. They also had the option to provide additional comments.

Phase II. The second questionnaire listed all the problems and strategies identified in the first round. The participants were asked to rate each problem on a 1–5 scale in regard to its severity, and rate each strategy on a scale of 1 to 5 regarding its chances for successful implementation.

Phase III. The data from phase II were analyzed to determine various statistics such as mean, median, mode, standard deviation, and number of responses,

Dear Participant:

Please use the following format to identify the Urban Environmental Problems in India, especially Mumbai, and rate them on a scale of 1 to 5.

Environmental Problem	***Least Detrimental***				***Most Detrimental***
1. _____	1	2	3	4	5
2. _____	1	2	3	4	5
3. _____	1	2	3	4	5
4. _____	1	2	3	4	5
5. _____	1	2	3	4	5

Please use the following format to identify the strategies to reduce the magnitude of the problems. Then rate each strategy on a scale of 1 to 5 regarding its chances for successful implementation.

Strategies to Reduce the Magnitude of the Problem	Chances for Successful Implementation Least				Most
1. _____	1	2	3	4	5
2. _____	1	2	3	4	5
3. _____	1	2	3	4	5
4. _____	1	2	3	4	5
5. _____	1	2	3	4	5

Additional Comments:

_____

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Figure 1. Phase I questionnaire.

for each response, using SPSS software. A hierarchical cluster analysis was used to identify common sets of rating pairs to propose categories for reaching consensus. The phase III questionnaire used the same statements as the second round and asked the participants if they would like to modify their answers based on the responses of the other participants. Each participant was given the analysis of the data collected in phase II and a list of comments made in the second round. After conducting statistical analysis, a trend towards consensus was documented at the conclusion of the third phase.

Phase IV. A group discussion was held in the fourth and final phase of the study after the participants were provided with the results of the third phase. This open forum brought together the entire panel so that the group could discuss the implementation plan to support the strategies. At the end of a three-hour discussion, the group outlined the process of putting in place the essential elements of a framework to improve the quality of life in an urban environment, particularly Mumbai.

Results and Discussion

The Delphi study resulted in identification of urban environmental concerns and effective strategies that were most likely to succeed in mitigating those problems. The issue of "creating public awareness" was ranked the top priority. The second issue concerned more effective management of solid and liquid waste, which is essential to ensure a clean and healthy urban environment. The results described below are listed in the same order as ranked by the panel with number one representing highest priority.

1. Increase public awareness and educate the youth about social and health problems through training, technical assistance, information exchange, and collaborative workshop-type activity.
2. Reduce major environmental health risks threatening urban and periurban populations by helping to finance introduction and extension of basic service infrastructure. Effective solutions will have to deal with hygiene habits and sanitation in combination.
3. Improve coordination of sewage treatment, sanitation, and water supply alternatives. This should be accomplished on a scale that demonstrates medium-term success and replicability.
4. Build on the most effective urban environment initiatives underway.
5. Remedy environmental problems of unsound residential locational decisions through collaboration with urban private-sector counterparts. Relocating people is politically difficult. However, concentrated settlements pose environmental, health, and safety hazards too serious to ignore.
6. Promote teamwork and collective decision-making among the municipality and its counterparts regarding responsibilities in planning, zoning, and basic services.
7. Improve Mumbai municipality's skills in urban environment priority-setting, policy-making, and project formulation and administration. Utilize nationwide municipal associations and regional networks as outreach vehicles.
8. Encourage and assist initiatives to improve local environmental well-being, including introduction of fiscally and technologically appropriate basic service infrastructure alternatives. Replicate community-action models that have been successful in tackling unmet basic service needs.
9. Identify and establish urban environment monitoring capabilities. Access expertise on appropriate technologies and project methodologies to do so.

The participants' comments have been summarized in the following paragraphs. The health effects of inadequate solid and liquid waste management are difficult to isolate from those arising from other causes. However, unsafe water is one of the major sources of urban environmental pollution. Water contamination has serious implications for ecosystems, human health, and the economy because of fecal and solid waste accumulation. These are due to lack of infrastructure; extensive, inappropriately located informal housing; and poor performance of public services by the municipality.

The lack of adequate sanitation facilities is a primary cause of fecal contamination of urban water supplies. Slums in Mumbai do not even have a rudimentary sewage system, so many households rely on septic tanks, while some dispose human waste directly into the sea and other bodies of water. Septic tanks, however, are rarely maintained properly, causing overflows that contaminate groundwater supplies. The transmission of water-borne diseases is also dependent on hygiene habits, which are frequently related to the unavailability of adequate supplies of water.

Urban solid waste is likely to expand more than twice as fast as the population, since the amount of waste per capita increases as incomes rise. At present, an estimated 10%–30% of such waste is not getting collected at all, and much of what is collected ends up in uncon-

trolled dump sites, leading to leachates that contaminate groundwater and contribute to the proliferation of disease-carrying pests. Some uncollected wastes are burned, adding to urban air pollution.

The participants concurred that the city of Mumbai can facilitate locally based efforts to address urban environment if it has a coherent and flexible strategic framework. that is put into practice by one or several program units dealing with urban environment areas. The framework proposes outlining and detailing: (1) urban environment objectives, (2) urban policy guidelines, (3) development of criteria for selecting urban environmental projects, and (4) action plan framework.

This framework is suitable for ongoing use and modification even while the program structure may change. It is specific enough to support clearly focused short- and medium-term program planning. At the same time, it is flexible enough to coordinate or combine with other sector strategies and to respond to new developments.

The findings of this study highlight public awareness, environmental health, solid waste, and water issues. Professionals in Mumbai concur that the city's pollution problems are acute, and the health implications of water contamination are urgent. The health connection is critical since it is a major motivator capable of generating broad-based commitment to environmental issues. Although the municipality cannot afford capital-intensive basic service infrastructure on its own, it can address the most urgent urban environment needs.

Homi Bhabha Centre for Science Education (HBCSE) at Mumbai undertook a three-year health education program aimed at finding out students' understanding of different aspects of health and the manner in which they understand the spread of communicable diseases. The first part of this project is presented in Mahajan and Chunawala (1999). The results indicate that students have a poor/unsatisfactory understanding of several aspects—nutrition, hygiene and sexual behavior—that affect health. The work carried out on students from different socioeconomic backgrounds highlights the poor performance of tribal students coming from remote areas. Traditional norms and the role of the family are losing their importance in governing young people's sexual behavior in India. School-based programs are needed that will provide students with accurate information about nutrition, hygiene, contraception, and sexually transmitted diseases.

Conclusions

India's postindependence story is a tale of pollution and congestion, uncontrolled growth and degradation, and yet, a tale of survival. Population increases in urban areas such as Mumbai have spawned an extensive and septic sprawl of informal settlements. Migration has exceeded the capacities of existing services and infrastructure. This Delphi study provided the environmentalists in India with an outline of the process for putting in place the essential elements of the framework to improve the quality of life in an urban environment.

There was a strong consensus on environmental concerns in Mumbai and the participants concurred that public interventions are necessary to protect the environment. Since the city is not adequately equipped to provide sophisticated technical support for cleaner industrial processes, it may be helpful to identify and access resources in the US and other developed countries. While financial investment is undoubtedly important, in the long run, environmental consciousness among the economically underprivileged is necessary for preserving the environment and natural resources. The respondents in this study concluded that such needs can be met through a combination of education, training, seminars, workshops, and exchange programs coordinated with infrastructure financing.

One of the most important aspects of environmental education is to develop a sense of stewardship among the young people who will inherit the problems and solutions that are being developed today. In addition, existing education outreach programs to mentor future scientists and to cultivate awareness among tomorrow's taxpayers and voters must be expanded. Education is key to the production of future generations of environmental scientists and to the development of an environmentally conscious and knowledgeable work force and citizenry.

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