Air Quality Information Disclosure in China: Needs and Capabilities

Jianying Lu and Lei Zheng
School of International Relations and Public Affairs, Fudan University
220 Handan Road
200433, Shanghai
{ 11210170052, Zhengl}@fudan.edu.cn

ABSTRACT
Air quality issue has become a global problem and air pollution is a serious threat to human health and the environment. This paper studies the public needs and government capabilities required as efforts of making air quality information public in Shanghai, China. It aims to explore people's various needs for air quality information and the challenges government is faced with in satisfying these needs. The paper also provides recommendation to Shanghai Environmental Monitoring Center with regard to how to satisfy or balance the various public needs.

Categories and Subject Descriptors
H.4.2 [**Information Systems Applications**]: Type of systems – e-government applications

General Terms
Human Factors, Management, Theory

Keywords
Disclosure; Air quality; Needs; Capabilities; China

1. INTRODUCTION
Air quality issue has become a global problem and air pollution constitutes a serious threat to human health and environment. In China, with the acceleration of economic development, major cities are faced with complex air pollution. Accelerated urbanization and transportation needs result in the continuous growth of motor vehicles. While the traditional problems of air pollution have not been solved and the new sources of air pollution appears such as ozone pollution, small particle pollution, photochemical smog pollution and so on.

In 2011, two events in China aroused public attention on air quality issue. One is the air quality data in Beijing monitored and reported by U.S. Embassy in Beijing. The data shows that according to the index of PM 2.5, Beijing's air quality often reaches the level of "serious pollution". PM2.5 refers to the particles which are less than or equal to 2.5 micron in diameter in the atmosphere. It is also known as the particulate matter which can be inhaled into lungs. The other is the four consecutive days with serious haze in Shanghai in May 2011, which rarely happened in the history of Shanghai's air quality monitoring. These events made the public worried and even panic about air quality.

As a result, public attention and concerns on air quality increases dramatically in China in 2011, so is public pressure on government to disclose and report accurate, timely, and high standards air quality information to the public, while traditionally, these data were not open to the public and were mainly held within the government for internal use. Under this backdrop, in the end of 2011, Shanghai Environmental Monitoring Center (SEMC) started an initiative to improve and enhance services on air quality data reporting and forecast.

This paper studies public needs and government capabilities required in Shanghai's efforts of making air quality information public. The study attempts to identify different needs of people related to air quality and then make recommendations to related government agencies with regard to measures to be taken.

2. RESEARCH DESIGN AND METHODS
The study aims to explore people's various needs for air quality information disclosure and the challenges government is faced with in satisfying these needs. The paper also provides recommendation to government agencies with regard to how to satisfy or balance various public needs. It comprises of three phases.

2.1 Best Practices Study
The first phase is best practices study. The study tries to find some successful cases and lessons learned with regard to air quality information disclosure in foreign countries and other areas in China. Practices in United States, Britain, European Union, Canada, Singapore, Hong Kong and Pearl River Delta Region in China are identified and selected. Through studying the websites for air quality information in different countries and regions and related literature, we summarized the principles and practices of these countries and regions, including their data, standard, channel, form, spots, frequency, languages and other aspects related to air quality information disclosure.

2.2 Qualitative Study: Focus Group and In-depth Interviews
With a qualitative approach, the second phase of study explores different public needs for channels, forms, spots, frequencies and languages of air quality information disclosure by various demographic groups. Challenges for government to satisfy public needs for air quality information disclosure are also examined.

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Focus group and depth interviews are conducted to investigate the research questions covering various demographic groups in Shanghai, including college students, white-collar workers, foreigners, visitors, senior citizens, respiratory diseases patients, as well as groups who care about air quality such as full-time housewives and teachers in kindergarten and primary school. During the interviews, the study paid attention to the different needs of various people, especially the needs of the vulnerable groups such as respiratory diseases patients, senior citizens and children. Ten college students attended focus group and depth interviews were made with 25 people, including medical doctors, white collar workers, taxi drivers, foreigners, elderly people, citizens who suffer respiratory diseases, who take outdoor activities frequently, who live in suburbs, and who especially care about air quality such as full-time housewives and teachers in kindergarten and primary school. In addition, two civil servants working in the field of air quality information disclosure were also interviewed. Altogether, 37 people were interviewed, and the average duration of the interviews is about half to one hour. Based on the focus group and interviews, we designed and improved the questionnaires for survey.

2.3 Quantitative Study: Survey

The third phase is to conduct a survey with residents and visitors in shanghai by using a self-completed questionnaire which is designed based on the findings in phase one and phase two of the study. Sample size of the survey is 533 and 526 of them are valid. Who finished questionnaires include different kinds of people. They are ordinary citizens of Shanghai who live in downtown and suburbs, travellers, college students, kindergarten teachers, doctors, white collar workers, primary school teachers, full-time mothers, taxi drivers, foreigners, old people and so on. Quantitative data analysis will be carried out to examine the generalizability of findings in phase two.

This paper will mainly present the findings in phase one and phase two. Finding from Phase three will be briefly introduced.

3. FINDINGS: BEST PRACTICES STUDIES

3.1 Principles Learned for Government Information Disclosure

Useful lessons are learned from the practices of information disclosure in foreign countries and other regions in China to guide the practice in Shanghai. “Open Government Directive” was released in the US in 2009. It was intended to direct executive departments and agencies to take specific actions to implement Open Government Initiatives [2]. Three principles form the cornerstone of open government according to the Directive: transparency, participation and collaboration. Among them, the principle of transparency is closely related to this study. Transparency can promote accountability by providing the public with information about what Government is doing.

In addition, Open Government Working Group (2007) defined 8 principles of open government data. They are complete, primary, timely, accessible, machine-processable, non-discriminatory, non-proprietary and license-free. First, “Complete” means that all public data should be made available. “Primary” means that data should be published as collected at the source, with the finest possible level of granularity, not in aggregate or modified forms. “Timely” requests data should be made available as quickly as necessary to preserve the value of the data. “Accessible” requests data to be available to the widest range of users for the widest range of purposes. “Machine-processable” means data are reasonably structured to allow automated processing of it. “Non-discriminatory” means data should be available to anyone, with no requirement of registration. It aims to reduce geographical digital divides and tries to ensure everyone the data and information of government. The principle is associated with the conception of e-inclusion. “E-inclusion” means both inclusive ICT and the use of ICT to achieve wider inclusion objectives [2]. It focuses on participation of all individuals and communities in all aspects of the information society. It focuses on six priorities. They are “address the needs of older workers and elderly people, reduce geographical digital divides, enhance e-accessibility and usability, improve digital literacy and competences, promote cultural diversity in relation to inclusion and promote inclusive e-Government.” [3]. “Non-proprietary” implies that data are available in a format over which no entity has exclusive control. Finally, “License-free” requests data should not be subject to any copyright, patent, trademark or trade secret regulation. Reasonable privacy, security and privilege restrictions may be allowed as governed by other statutes.

3.2 Best Practices of Air Quality Information Disclosure

There have been a number of successful practices of air quality information disclosure in foreign countries and Hong Kong of China. In America, AIRNow is a website application to provide the public with easy access to national air quality information [4]. The website offers daily AQI forecasts as well as real-time AQI conditions for over 300 cities across the US. It reports the AQI combined with PM2.5 and ozone index in the form of dynamic map, colors and levels. Besides, various forms of health advices for kids, students, teachers, and older adults can be found on the website. Furthermore, it updates air quality information hourly and provides “forecasts” of air quality as well. With the development of social media, people can also receive air quality information through applications like Twitter, Facebook, APP, and RSS.

British government has built up special website to disclose air quality of London[5]. Information disclosed on the website includes nitric oxide, sulfur dioxide, ozone, carbon monoxide, PM10 and PM2.5. Meanwhile, air pollution index is divided into 1-10 and is classified as "low (1-3), medium (4-6), high (7-9) and very high (10). The level of pollution is showed by colors and numbers on dynamic maps. Besides, this website also provides air pollution prevention advices to guide the public take appropriate protective measures in different degrees of air pollution. Citizens can get air quality information by application of iPhone and android. Air pollution hotline made by UK government is also a channel to know air quality information

European Environment Agency (EEA) is an agency of the European Union[6]. It provides sound and independent information on the environment, mainly the hourly ozone pollution in the forms of dynamic map, index, colors and charts on the website. 25 languages of the member countries are all available on the website to meets the different language needs of member countries. EEA has two mandates. One is to help the community and member countries make informed decisions about improving the environment, integrating environmental considerations into economic policies and moving towards sustainability. The other is to coordinate the European environment information and observation network. EEA tries to achieve two-way communication with their clients in order to correctly identify their information needs, and make sure that the information provided is understood and taken up by them.

Hong Kong also has a worth-learning practice in terms of air quality information disclosure. The pollutants it reports include

inhalable suspended particulates, sulfur dioxide, nitrogen dioxide, ozone and carbon monoxide[7]. It uses Roman numbers (I、II、III、IV、V) to classify the air quality and people can obtain air quality information from the website, newspaper, radio, television and hotline. Also, it provides specific advices to ordinary people, children, the old and people who do outdoor activities. What's particular is that the spots for disclosing air quality data in Hong Kong is divided into general monitoring spots and roadside monitoring spots [2]. In short, Hong Kong adopts a citizen-oriented approach in air quality information disclosure and people can obtain clear, scientific and true information about air quality[1].

In sum, these principles and practices of air quality information disclosure in foreign countries and HK are citizen-oriented and are inclusive of various demographic groups. They all attempt to provide accurate, complete, primary, timely, and accessible air quality information to the public and make it non-discriminatory.

In mainland China, practice of air quality is still at a very preliminary stage. There does exist air quality information disclosure and reporting practices in mainland China, but it hasn't seems to meet public needs for information.

Based on the above research, we summarize best practices of air quality information disclosure into Table 1 as follows:

Table 1. Best Practices of Air Quality Information Disclosure

Category/Country	USA	UK	European Union	Hong Kong, China
Pollutants	Ozone, PM2.5	NO,SO2,Ozone,CO,PM10, PM2.5	PM10,PM2.5,CO2,NO2,Ozone	Inhalable particles,SO2,NO2,Ozone, CO
Language	English	English	25 Languages of EU Member States	Chinese and English
Frequency	Hourly	Hourly	Hourly	Hourly
Spots	Cities	Monitoring stations, highways, river, etc	EU Member States	General stations and roadside stations
Channel	Applications of iPhone and android, social media, RSS, email	Website, hotline and applications of iPhone and android	Social media, radio, newspaper, information screen, Internet and RSS	Website, newspaper, radio, TV and hotline
Form	Static and dynamic map, comparison of air quality in different time and cities, flags with different colors	Ordinary, satellite and hybrid maps, 3D dynamic graph, aerial photographs	Road map and satellite map, graph	Table, graph
Specific Crowd	Health care providers, children, students, teachers, the elderly, adult, air forecasters	None	Citizens and related organizations	Ordinary citizens , children, the elderly, outdoor workers
Knowledge and Advice	Knowledge of air pollution; provide advices	Knowledge of air pollution, news and reports of air quality	Video, charts and articles on environmental issues	Knowledge of "air pollution index and you"; provide advices

4. FINDINGS: FOCUS GROUP, IN-DEPTH INTERVIEWS AND QUESTIONNAIRE SURVEY

4.1 Public Needs: Knowledge, Information, Advice, and Clean Air

The study finds different needs of people related to air quality. First, knowledge about air quality is needed to raise their attention to air quality. Next, air quality information is needed to ensure people's awareness of air quality. What's more, health advices are needed to help the public to take protective actions with respect to the particular status of air quality. Ultimately, what people need most is clean air.

4.1.1 Needs for Knowledge about Air Quality

Needs for knowledge about air quality has been put forward by 67% of the interviewees in the survey. A number of interviewees point out that government should carry out more public campaign to education the public with knowledge about air quality so as to raise public attention to air quality.

Questionnaire survey shows that 69.4% of the interviewees are concerned about air quality. Some interviewees put forward that government should offer more knowledge to those who are very concerned about air quality to help them know about the relationship between health and air quality. For those who are not very concerned about air quality, government should educate them to improve their concern on air quality. Full-time housewives interviewed raise up that education on the effects of air quality on health should begin in primary school to cultivate children's attention to air quality and environmental protection. People who often do outdoor sports think lectures could be organized to make air quality knowledge widely known.

4.1.2 Needs for Air Quality Information

Some interviewees also raise that in order to be fully aware of air quality, and they have the rights to know more accurate, complete, and timely information about air quality from the government. Some point out that although how they judge air quality by themselves through eye and nose is not scientific, they also doubt the accuracy and trueness of current air quality information reported by government. Some think that government information about air quality is manipulated for various political and economic reasons.

4.1.3 Needs for Advices and Alarms

In addition to air quality information, 81% of the interviewees surveyed also hope to receive some health advices from government under different air quality situations. 68% of the interviewees think that air pollution affects their daily behavior. They will not go out doors or will take protective measures when air quality is terrible.

Questionnaire survey shows that air pollution affects more on those who have respiratory diseases, who have children under 18 years of age and foreigners. Interviews with citizens show that primary school teachers, white-collar workers, the air sensitive and the old think health advices information would be very helpful to them. Kindergarten teachers want expert suggestions for taking children out. One primary school teachers also asked that "when air quality information is reported, advices on how to protect themselves should also be provided for young children and the old." However, the questionnaire survey shows that there are still 27% of the interviewees will not take any protective measures against bad air quality. For those people, government should provide advices more actively.

Besides, some interviewees mention that they also need alarms in-advance when major air pollution or incident happens. A foreigner who lives in Shanghai said, "When air is toxic or dangerous and might cause health problems, government should give alarms in advance."

4.1.4 Needs for Clean Air

Questionnaire survey shows that ultimately, in addition to the needs for knowledge, information and advices, public needs for clean air are the most important. 56% of the interviews want the air quality to be good and suitable for them to live a healthy life. When asked whether they want to know the true information about air quality, a college student said, "What I really care about is whether government will take measures to improve air quality."

Questionnaire survey also shows that there are only 11.2% of the citizens who have positive evaluation on air quality of Shanghai. 41.9% of the citizens think air quality in Shanghai is very bad. Different people have different evaluation on the same air quality. It is probably related with people's expectations of the air quality. The higher they have expectations on the air quality, the worse they will think the air quality as. Survey shows that those who are young, who have respiratory diseases, who have children under 18 years of age, local people, and foreigners tend to have bad evaluations on the air quality of Shanghai. For example, according to the survey result, 87% of the foreigners think air quality of Shanghai is terrible. They are mainly from developed countries. One student from United Kingdom said that sky of Shanghai is always dirty. The lady from the United Stated said that she missed blue sky very much.

4.2 Impacts: Attention, Awareness, Action and Health

Related to each type of needs mentioned above, research also finds different effects and impacts on the public with regard to air quality information. They are public attention to air quality, awareness of air quality, and action for protection, and Health. First, knowledge about air quality could raise public attention to air quality. Second, air quality information can ensure public awareness of air quality. Next, health advices could help the public to take protective actions with respect to the particular status of air quality. Ultimately, clean air can contribute to people's health.

Among these impacts and effects, public attention to air quality is the starting point. Only when the public start to care about air quality, will they be interested in being aware of the quality of air. Furthermore, only when the public are informed with the status of air quality, will they be able to take actions to protect themselves or prevent themselves from being hurt. At last, their ultimate goal is to maintain health.

4.2.1 Attention to Air Quality

The study finds that air sensitive group, full-time housewives and foreigners concern about air quality most. Some interviewees also require government to carry out more public campaign and education to raise public attention to air quality.

The research also finds that a number of people do not pay much attention to air quality. A lot of interviewees state they are usually not concerned about air quality information. Before the interviews, we have assumed that those who often do outdoor activities will be more concerned about air quality. However, in fact, taxi drivers, tour guides and even outdoor sports activities do not pay much attention to air quality information. Usually they only focus on weather forecast.

4.2.2 Awareness of Air Quality

The study finds that currently most interviewees judge the air quality by subjective sensory perceptions, such as air visibility, color of the sky and the small of air. Two different perceptions of the interviewees are found with regard to air quality. First, native people in China have contradictory opinions about air quality in Shanghai. Interviewees from Shanghai and Yangtze River Delta think that the air quality in Shanghai was generally good, while some interviewees think the air quality in Shanghai was bad. One interviewee from Inner Mongolia said that air quality after the dust in Inner Mongolia is better than in Shanghai.

On the other hand, almost all foreign residents in Shanghai have terrible impression on air quality in Shanghai, especially foreigners from developed countries. A student from the United Kingdom said, "air quality in Shanghai is not as good as that in the United Kingdom. The sky in Shanghai often looks gray." One lady from the US said "I miss blue sky."

4.2.3 Actions for Protection

The study finds that currently some interviewees take various actions to protect themselves in unhealthy, polluted or even hazardous days in terms of air quality. Some interviewees choose to stay home or not to do outdoor activities when the air quality was unhealthy. A doctor said," I would choose to wear a mask if I will go out on a polluted day."

The air sensitive group is found to be more responsive to pollutions. One student who have severe rhinitis said, "if air quality is terrible, I will definitely not go out. If I go out on the day with poor air quality, my nose will be very uncomfortable." On the contrary, many people mentioned that they wouldn't take any protective actions at all in a polluted day.

4.3 Needs for Data, Standard, Channel, Form, Spots, Frequency and Languages

The research also finds that public needs for the data, standard, channel, form, spot, frequency and languages with regard to air quality information vary. The findings are presented as follows.

4.3.1 Data

In terms of the data for disclosure and reporting, most interviewees do not show great interest in the specific data about

pollutants, and what they really want to know is not plain data but whether the air quality is good or bad. Kindergarten and primary school teachers said," what are the pollutants is not what I am concerned about, I just want to know whether the air quality today is good or bad".

However, there are still some interviewees who prefer to know the data about pollutants. Some doctors, foreign students, tourist guides, foreigner residents and those who do outdoor sports want the information of the main pollutants, such as sulfur dioxide, nitrogen dioxide and respirable particles.

4.3.2 Standards

In terms of data standards, some foreign interviewees want to know what contributed to the air pollution and the data of PM 2.5 in terms of international standards. One foreign resident interviewed also said, "International standards should be adopted to report air quality information in China." Some Chinese interviewees also emphasize the need to enhance current air quality standards of China to match with the increasing living standards and public attention to air quality.

4.3.3 Channels

The public have very different needs with regard to channels for air quality reporting according to the research. Retired people tend to receive information from television and radio, so they hope that air quality information could be reported on television and radio. For some people in suburbs, taxi drivers, doctors, the old and those who do outdoor sports, radio and television are still the main channels for them to get information.

For young people, they prefer to get information from new media. Specifically speaking, primary school and kindergarten teachers prefer to obtain air quality information from mobile TVs on buses and metros, touch screen on taxis, free newspapers and magazines in metro stations. White-collar worker, foreign students and the sensitive group hopes to receive the information from mobile TVs on buses and metros, social media, mobile newspaper, radio and LED screen in commercial areas.

Besides, tour guides mention short messages and the Internet. Full-time housewives prefer LED in the community and neighborhood committee lectures. Some foreign interviewees state that they do not usually read Chinese newspapers and watch Chinese TVs, so they want convenient channels to get information such as the website in English, hotline number in English, smart phone applications and so on.

4.3.4 Forms

Several forms of the air quality reporting are raised by the interviewees. They were words, colors, cartoons, animation, video and dynamic map. Primary school teachers suggest that a series of cartoons will be the best form for children, and full-time housewives and kindergarten teachers would like animation very much.

White-collar workers, the sensitive group and foreigners prefer to see a dynamic map to show the spacial trends of air quality. White-collar workers also suggest that cartoons or dynamic map will be great help for them. The air sensitive group also mentions cartoons, doctors, tourist guides and outdoor sports lovers support dynamic maps and animation. Foreigners prefer dynamic map together with numbers and colors. Furthermore, some foreign students urgent that video would be a better form to report air quality information.

4.3.5 Spots

There are two main views about the spots of air quality reporting. One is to report air quality information according to administrative districts and the other is to report air quality information according to commercial districts. Kindergarten teachers, suburb residents, foreign students, the old, full-time housewives and outdoor sports activities think air quality should be reported according to administrative districts while doctors and tour guides believe air quality should be reported according to commercial districts.

Besides, primary school teachers, white-collar workers, taxi drivers and air sensitive people think that it is feasible to report air quality information either according to administrative divisions or according to commercial districts. What is special in the findings is that foreigners think that it would be better to report air quality information according to specific busy streets and school areas.

4.3.6 Frequency

Most of the interviewees prefer that air quality information should be reported twice a day or three times a day. Primary school teachers, kindergarten teachers, doctors, the old, full-time housewives and those who do outdoor sports actively prefer to know air quality information twice a day, while white-collar workers, suburban residents, taxi drivers and foreigners prefer to know air quality information three times a day.

Tour guides need air quality information once a day at night in advance for forecast. What is worth noting is that foreign residents emphasize that air quality information should be reported hourly in school areas and foreign students raise that the frequency should be changed with the speed of air quality changes.

4.3.7 Languages

Most domestic interviewees agree that Mandarin should be the basis language for air quality information reporting, while most foreigners suggest that English should be included as the first foreign language to be used in information reporting. Besides, kindergarten teachers and air sensitive people also point out that English should be used. Foreign students think English would be easier for him to understand and kindergarten teachers thought it would create a good atmosphere for children's English education.

Meanwhile, the air sensitive people and full-time housewives refer Shanghai dialect. These people are either Shanghai natives or had lived in Shanghai for a long time. Shanghai dialect would be more acceptable for them.

4.4 Needs by Demographic Groups

The research also finds that public needs for air quality information reporting vary from person to person. In the above analysis, we have demonstrated that different people have various needs for air quality information reporting. In this section, we will make an in-depth analysis on public needs by different demographic groups. The needs of people with different education levels, different income, different nationalities, different residential locations, different health conditions and different ages are examined specifically.

4.4.1 By Education Level

People with different education level have indicated different needs for the language of air quality information reporting and attentions to the importance of air quality. The research finds

those who have received higher education have higher more requirements for languages. They hope that air quality information can be reported in Mandarin as well as in English while the others just want Mandarin, as they do not speak English well.

Meanwhile, those who have received high education usually pay more attention to the importance of air quality. Highly-educated full-time housewives said that "knowledge on air quality and environmental protection should be started to deliver from primary school." It is because of their education experiences that they realize that the air quality improvement is a long-term process and relies a lot on the education to children. But those who haven't received higher education tend to passive with regard to air quality issues. They usually get what others give them and lack fundamental initiative to search information and protect themselves from polluted air.

4.4.2 By Income

People with different income also show different needs for the channel of air quality information reporting. Social media and smart phone applications are the main channels to for high-income people to receive air quality information. High-income people usually go out by driving their own cars, so it is rare for them to take public transportations. Middle class people usually get air quality information from social media, mobile TVs on buses or metros, by which they take to work every day. People with low income often get air quality information from radios and TVs. Some low-income people are either retired or unemployed. They spend a lot of time staying home, and radios and TVs are their most important information sources.

4.4.3 By Residential Locations

People in different districts have different degree of concerns on air quality information reporting. Urban residents usually attach great importance to air quality and have more needs on air quality information reporting than suburbs residents, while suburban residents are almost not concerned about air quality at all. A taxi driver in urban area said," I am always concerned about air quality in the city and I will choose to do different sports according to air quality. If air quality is poor, I will play table tennis. If air quality is good, then I will go running."

But suburban residents basically do not care air quality. One suburban citizen said," I am not concerned about air quality. Sometimes I incidentally noticed the air quality forecast just because I am looking at the weather forecast and the air quality forecast is after the weather forecast."

Why does this difference exist between urban residents and suburban residents? We think that there may be two reasons. One is that air in suburbs is cleaner than that in urban areas. Since there are lots of sources of air pollution such as automobile exhaust emissions in urban area, air quality is often worse in urban areas. Therefore, people in urban areas suffer the air pollution and paid higher attention to air quality. The other reason may be that urban residents have access to more resources of air quality information than suburban residents. It could be assumed that they know more about air quality than suburban residents. Resulted from their difference in awareness of air pollution, it is understandable that urban residents concern more about the air quality problems.

4.4.4 By Nationalities

Local people and foreigners have different needs for air quality information disclosure and reporting.

The questionnaire survey shows that Chinese interviewees mainly wish to obtain air quality information from mobile TV, TV and social media while foreigners prefer to obtain air quality information from mobile TV, websites and APP application. Chinese interviewees expect to know data about particular inhalable particles, PM2.5 and sulfur dioxide index while foreigners want to know the index of particular inhalable particles, PM2.5, carbon dioxide and ozone. Foreigners have higher requirements on data of ozone for the reason that foreign countries have devoted more efforts on the education of "ozone and health".

The survey finds that compared with foreign interviewees, Chinese interviewees are more demanding on air pollution alarms. Many Chinese people hope to get alarm when the air pollution is mild and medium, but most foreigners require receiving alarms when air pollution is high and medium. 33% and 29% of the Chinese people want to know the pollution alarm in next 48 hours and 72 hours, but 76% of the foreigners only hope to know the pollution alarms in next 24 hours. Not surprisingly, foreigners want air quality information to be reported in English while most local people want Mandarin.

4.4.5 By Health Conditions

Obviously, air sensitive people and non-sensitive people have different needs for the frequency of information reporting and information about special pollution. Except the requirement for air quality information reporting at least two or three times a day, air sensitive people also have needs for air quality forecast. It will provide them with necessary information to decide whether to go out or not. An interviewee who suffers from severe rhinitis said, "If air quality is terrible, I would rather not go out."

Sensitive people also pay more attention to the advices. An interviewee who suffer from asthma referred that "government should make air quality knowledge popularity and increase attention to children and the old to tell them what they can do and what they should avoid doing in different situations of air quality."

4.4.6 By Age

Many interviewees mentioned that Children and the old should be paid more attention to, because they are more sensitive to air quality. Primary school teachers pointed out, "When air quality information is reported, advices on how to protect themselves should also be provided for young children and the old." One interviewee who is about 60 years old said, "I am becoming weaker and weaker these years and I want to know whether it will be safe for me going out for walk when air quality information is reported."

Based on the above findings, we summarize public needs related to air quality (AQ) into Table 2 as follows:

Table 2. Public needs related to Air Quality

Types of Needs	Specific Requirements for Information Disclosure and Reporting	Needs by Demographic Groups

Knowledge about AQ, Information of AQ, Health Advices, and Clean Air	Data, standard, channel, form, spot, frequency and languages	By education level, income, residential locations, nationalities, health conditions, and age

4.5 Government Initiatives: Campaign, Disclosure, Service, and Improvement

Given the above assessment on public needs for air quality information, civil servants interviewed stated that in order to satisfy these public needs related to air quality, government need to take a couple measures respectively. There initiatives include public campaign to provide the public with knowledge about air quality, information disclosure of air quality, services to and communication with the public to provide advices for protection, and measures to improve air quality.

Some government interviewees also emphasized that there seems to be a close relationship among public campaign, information disclosure, services, and improvement. Public campaign would increase public attention to air quality, which will make the public to request more information. Furthermore, when more information is disclosed, the public would also ask for more advices and services to protect themselves under particular air quality conditions. Finally, civil servants addressed that once information about air quality is made public, more informed citizens might then require government to take more effective measures to improve air quality. Otherwise, the public might become more unsatisfied with the air quality, and their pressures on government to improve air quality might rise after the disclosure. Therefore, some interviewees believe that air quality information disclosure may lead to more air quality improvement measures of government and may achieve cleaner air in the end.

4.6 Tension between Public Needs and Government Capabilities

In order to satisfy various public needs and implement government initiatives effectives, four types of government's capabilities are required including the capabilities of carrying out public campaign, disclosing air quality information, providing services and advices and improving air quality. However, government capabilities are usually limited for various reasons such as technological limit, budget shortage, lack of human resources and so on. Therefore, a tension exists between public needs and government capabilities, and constitutes a serious challenge to government. Especially, the research finds that the capability of improving air quality conflict with and constitute constraints to the capability of disclosing air quality information. One interviewee worried that "without air quality improvement, complete information disclosure might make the public unhappier and even panic when they know that the air quality in the city is so bad and won't get any improvement." Therefore, some people in the government even suggest postponing air quality information disclosure before the air quality is significantly improved.

How to balance the capabilities of government and public needs require more strategic and feasible solutions. One civil servant in the area air quality information disclosure said, "Some people' demands are too high for the technology to meet now. The technology gap does exist. We will do feasibility assessment on these needs, categorize these needs by priority, and then determine which need can be met in the short term and which needs will take a long time to satisfy. At last, we will make step-by-step strategy to meet public needs according to the feasibility and priority. For needs that are easy to meet, we will put them into the short-term plan and some needs which are difficult to accomplish, we will formulate a longer time plan to realize them. For the needs which are important but not technically feasible, we will supplement them with other public services."

4.7 Framework Building

By summarizing the studies and analysis above, a theoretical framework of air quality information disclosure is built (See Figure 1). The framework shows the relation among government capabilities, initiatives (input), satisfying public needs (output), and impacts on the public (outcome). Only with adequate government capabilities, government will be able to carry out a number of initiatives and measures effectively, and the effectiveness of these initiatives could satisfy public needs for knowledge, information, health advices and clean air, and eventually enhance public attention to air quality, awareness of air quality and actions for protection, and maintain health.

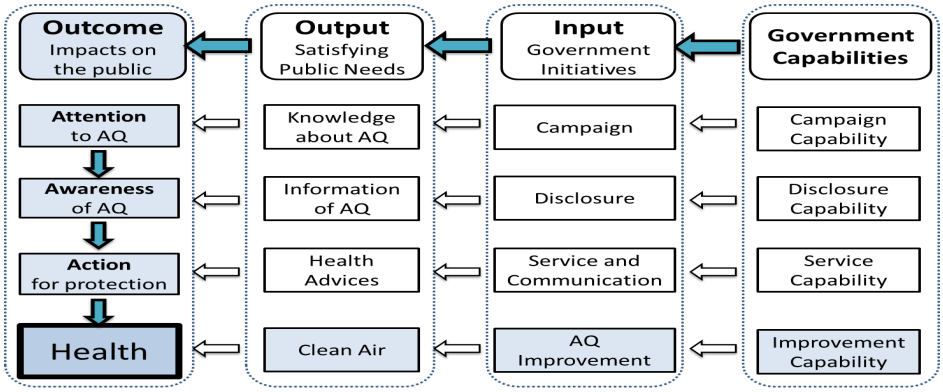

Figure 1: A Theoretical Framework of Air Quality Information Disclosure

5. DISCUSSIONS AND RECOMMENDATIONS

This paper examines various needs of the public for air quality information disclosure and the challenges government is faced with. Based on the findings and analysis above, we make a number of recommendations to the Chinese government with regard to satisfying the public needs and balancing the public needs with government capabilities as follows.

5.1 Provide Knowledge, Advices and Clean Air as well as Information

The study shows that, in addition to plain information about air quality, government should also provide the public with knowledge about air quality and health advices. Knowledge about air quality can help to arouse public attention to air quality. Since most people judge air quality by their subjective feelings, air quality information disclosure could provide the public with scientific, complete and accurate information about air quality. Health advices can help the public to take protective actions. For air quality sensitive people, health advices are especially important for them to take appropriate actions to protect themselves. Most important, government should try the best to provide clean air for the public ultimately.

Consequently, government should take various measures to satisfy public needs by carrying out public campaign, disclosing air quality information, and providing services and advices to the public. What's most important is that government should take effective measures to improve air quality continuously and consistently. Without clean air, great information disclosure might only make the public more discontent and even panic. Only when the air quality becomes better, will the public become really satisfied and healthy.

5.2 Take a Systematic Approach

Government should provide air quality knowledge, information and advices in a systematic and comprehensive way. Since different residents have different needs for the data, standard, channel, form, spot, frequency and language with regard to air quality information disclosure, government should provide complete, accurate, timely and accessible knowledge, information and advices about air quality in a systematic approach through various channels, forms, spots and languages with different frequencies. Only with a systematic approach, will various public needs be fully satisfied.

5.3 Satisfy Needs of Various People

Government should satisfy the needs of various people to achieve the principle of non-discriminatory and inclusion. "Non-discriminatory" principle of open government data is consistent with the meaning of e-inclusion. It means data should be available to anyone, with no requirement of registration. This research finds that demographic groups in terms of education, income, residential locations, nationalities, health conditions and age have quite different needs for air quality information disclosure. Government should make air quality information "non-discriminatory" and available to anyone to satisfy various needs and realize inclusion.

5.4 Enhance Government Capabilities and Make Strategic Plan

Government should improve their comprehensive abilities and make strategic plan to meet public needs step by step. The capabilities with regard to public campaign, information disclosure, services and air quality improvement should all be taken into account for enhancement. Given the gap between public needs and government capabilities, it will be difficult for government to satisfy public needs immediately and at once. Therefore, strategic plan should be made to meet public needs step by step by balancing the feasibility of meeting needs and the priority of needs. Accordingly, short term, mid-term and long term plan should be developed.

6. ACKNOWLEDGEMENT

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7. REFERENCES

[1] Chen, J. Hong Kong Air Quality Forecasting with Pollutants Index, Environmental Monitoring Management and Technology, 2 (1997), 6-7.

[2] Liu, X.P. & Zheng, L. New Trends of International E-Government: Inclusive Public Services, E-Governance, 2010 (12), 101-105.

[3] 8 Principles of Open Government Data. Open Government Working Group (2007).

http://www.opengovdata.org/home/8principle

[4] http://www.airnow.gov/

[5] http://www.londonair.org.uk

[6] http://www.eea.europa.eu/

[7] http://www.epd-asg.gov.hk/