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Environmental concerns and uncertainty communication for building public trust in environmental risk management: A case study of Maptaphut Municipality, Thailand

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Abstract

The study aims to examine the role of uncertainty communication in increasing public trust in the capability of public authorities and industrial agencies to provide effective risk management. First, the study demonstrated the relationship between social trust and environmental concerns held by lay people in contaminated sites. Then, relationships between trust and lay understanding of uncertainties associated with technical risk assessment and potential health impacts caused by environmental contamination were examined. Data was collected through the distribution of questionnaires to 181 people who currently live in the area examined in the selected case study, i.e., the Maptaphut municipality in Thailand. The results showed that trust in public authorities and industrial agencies could slightly predict environmental and health concerns because people become more knowledgeable and rely less on institutions when judging risks. In addition, trust was influenced by lay understanding of uncertainties associated with risk assessment and outcome uncertainty. Under the current risk communication, i.e., poor communication of information related to uncertainty, people with the ability to conceptualize uncertainties tend to have lower trust in public authorities and industrial agencies. The study concluded that explicit communication of uncertainty could increase perceived transparency of environmental risk management, thereby contributing to social trust.

Keywords: Social trust; Uncertainty; Environmental communication; Environmental concern

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1. Introduction

Rapid industrialization both in developed and developing countries has contributed to adverse impacts on environments and human health (Bhopal et al., 1988; Luginaak et al., 2002; Jadsri et al., 2006; Burningham, 2004). Similar to many industrial development areas in the world, the Maptaphut industrial estate development area in Thailand has struggled with environmental contamination problems for almost three decades (Decharut, 2005). Soil, water, and the atmosphere have been contaminated with several types of hazardous substances, compounds, and heavy metals, including Benzene, 1,3 Butadiene, Chloroform, 1,2 Dichloromethane, lead, mercury, and zinc (Thongra-ar et al., 2008; Wattayakorn et al., 2012; Tepanonndh et al., 2010; Chusai et al., 2012). The most serious problem is air pollutants, which are widely believed to be a cause of the high cancer rate and high rate of patients with respiratory disease in the area (Tanyanon and Vichit-Vadakan, 2012; Panientong et al., 2012). The study conducted by the Thai National Cancer Institute in 2003 showed that the rate of cancer patients in Rayong Province was far higher than in Bangkok City and the national average (Khuhaprema, 2010). Furthermore, the rate of patients with disease caused by polluted environments has increased steadily in Rayong Province since 2003 (Office of the Permanent Secretary for Public Health, Thailand, 2013).

This phenomenon has caused environmental concerns among the public; furthermore, public trust in institutions and risk management operated by public authorities and the industrial agencies has been gradually destroyed, resulting in high public anxiety, lack of public engagement in environmental risk management, and the emergence of conflicts among lay people, government, and industrial agencies. Many lay people have rejected information conveyed by public authorities and industrial agencies, and called for a fully transparent risk assessment process. Low trust in public institutions and/or industrial agencies is generally well recognized and has been reported in many previous studies (Slovic, 1993; Flynn et al., 1992). The impacts of destroying trust are immense and diverse. Besides hindering the continuous development of industrial activities, the loss of trust among parties also gives rise to a negative impact on environmental risk communication (Renn and Levine, 1991), which is a purposeful exchange of information related to risks between relevant parties (Covello et al., 1986). Several objectives of risk communication – ranging from informing parties about information related to risks, changing attitudes or behaviors, creating long-term public participation, and engendering trust itself (Covello et al., 1986 and Renn 1988) – completely rely on trust among communicators (Renn and Levine, 1991; Earle, 2010; White and Eiser, 2006). Destroying trust generates vast impacts on both communication and the management of risks.

Trust is an individual's confidence that the word, message, or actions of another individual can be relied on (Rotter, 1980); it has also been defined as the assured reliance on the honesty or integrity of someone or something (Webster's New World College Dictionary, 2010). Trust is hard to build and even harder to maintain (Slovic, 1999). Building and increasing public trust in risk management, regulation, or institutions depends on a range of factors, such as fairness, open access afforded by public participation, transparency, and dialogue (Brasbury, 1999). In the case of the management of environmental risks associated with industrial activities, communicating uncertainty associated with both risk assessment and the potential impacts could play a profound role in making risk assessment more transparent, and could consequently

generate public trust (Frewer and Salter, 2007). However, it was previously believed that uncertainty should not be communicated to non-experts because it might result in the public developing negative perspectives of the process of risk assessment, public distrust, and confusion related to adverse effects of a given hazard (Wynn, 1992). In fact, non-experts do have the ability to conceptualize the association of uncertainty in environmental risks and also to understand different kinds of uncertainty, such as uncertainty associated with the risk management process and uncertainty about potential impacts (Frewer et al., 2003). When uncertainty has been communicated to them, lay people might have more confidence in a mandatory risk management process and could recognize the importance of scientific research in order to minimize uncertainty. Therefore, ignorance regarding communicating uncertainty might eventually result in public distrust.

This study mainly emphasizes investigating whether lay people can conceptualize uncertainty associated with both risk assessment and potential impacts. It explores how lay understandings of uncertainty are related to trust in public authorities and industrial agencies. The study first investigates the relationship between public trust and environmental and health concerns held by lay people. Then, the influence of lay understandings of uncertainty on trust in public authorities and industrial agencies is examined. Two types of uncertainties, i.e., uncertainty associated with risk assessment and outcome uncertainty, are investigated. The Maptaphut industrial estate development area was selected as a case study due to the urgent need to rebuild trust and to improve risk communication in this area. Data collection was carried out by distributing questionnaires to 181 people who currently live in the selected area between October and November 2013. All collected data were deliberately inspected before performing multiple regression analysis and T-test for statistical analysis. A discussion on the roles of communicating uncertainty in building trust is featured in the final section.

2. Maptaphut industrial development area, Thailand

The Maptaphut Industrial Estate (MIE), located in the Rayong Province in Thailand, is one of the 29 industrial estates in Thailand. It is located at around 12.5 N (lat.), 101.5 E (long.), nearby the Gulf of Thailand. The project was first established in 1989 by the state enterprise, the Industrial Estate Authority of Thailand (IEAT), and the Ministry of Industry (Industrial Estate Authority of Thailand, 2004). MIE initially had a total area of 6.72 Km² that used to consist of agricultural farms, waste land, and small rural farming and fishing communities. In 2002, the area increased to 11.2 Km², and it was later found that many factories are situated in nearby residential areas (Decharut and Penchom, 2005). Currently, there are five industrial estates in Maptaphut area: Maptaphut, East Hemaraj, Asia, Padaeng, and RIL. About 1,800 factories and a seaport are situated in the area (Industrial Estate Authority of Thailand, 2004). Most of the industrial plants are petrochemical factories, coal-fired power plants, chemical fertilizer factories, and oil refineries. Since its first operation in 1990, many pollution problems have been reported by the public media. In 1997, it was reported that 1,000 students and teachers from Maptaphut Panphittayakarn School suffered from illnesses after inhaling the toxic emissions from factories situated nearby and were hospitalized for breathing difficulties, nasal irritation, headaches, and nausea. The Ministry of Education finally approved the relocation

of the school in 2005. The industrial development in the area has been critiqued by the public due to health impacts suffered by local people as well as other social impacts, including drug abuse, crime, and pregnancy among young people (Nuntavorakarn, 2008).

Environmental problems in Maptaphut, such as polluted air, wastewater, groundwater, and soil contamination, have concerned the public, industrial investors, governments, and NGOs. Among those problems, air contamination is perceived as the most serious problem (Tepanondh et al., 2010). According to the result of air quality monitoring conducted by the department of pollution control during 2007–2013, several types of Volatile Organic Compounds (VOCs) were found to be above the national standard. There are also other air pollutants distributed throughout the area, including nitrogen dioxide (NO₂), sulfur dioxide (SO₂), carbon monoxide (CO), and particulate matter (PM10) (Tepanondh et al., 2010; Chusai et al., 2012).

3. Theoretical context

3.1. Trust and environmental concerns

Trust can be defined as confidence in the capability, acts, character, honesty, or integrity of a person or organization (Earle and Cvetkovich, 1999). Trust relies on several components, including perceived competence, objectivity (lack of bias), fairness, consistency, and faith (Renn and Levine, 1991). Covello (1992) suggested that trust is determined by the following four factors: caring and empathy; commitment; competence and expertise; and honesty and openness. Many previous research studies discussed the contribution of social trust to environmental risk perception or environmental concerns (Flynn et al., 1992; Siegrist, 2000; Sjoberg 2001; Viklund, 2003). These studies mostly concluded that social trust has a reverse relationship with perceived environmental risks. Assumedly, people have limited knowledge of science and insufficient capability to determine risks (Gregory and Miller, 1998). Therefore, they have to rely on other parties. However, the power of social trust in explaining risk perception or environmental concerns is varying and limited because perceived environmental risk could also be affected by other factors such as knowledge, experiences, and ability to control the risk (Fischhoff et al., 1993). The study conducted by Duan (2005), for example, showed that the correlation between environmental risk perception and social trust was very small. It was assumed that people's knowledge and experiences related to environmental risks might be influential factors. Several studies, however, suggested that trust plays a crucial role in the development of risk communication and decision making in risk management (White and Eiser, 2006; Earle, 2010). For instance, Jardine et al.'s (2013) study found that a lack of cooperation in environmental risk management, identified by delayed mitigation and remediation measures and a prolonged and costly consultation process, had been caused by the misrecognition of issues related to trust, including value similarity and past performance of public institutions.

3.2. Communication of uncertainty and trust building

Several types of uncertainties are associated with environmental risk management due to the complexity of management processes which are related to:

- pollutant release into the environment;
- transports of pollutants in a variety of environmental conditions;
- a variety of potential health impacts; and
- the probability of adverse impacts on a human population which has different genetic characteristics (U.S. EPA, 2005).

According to Finkel (1990), uncertainty can be classified into the following four types:

- variable uncertainty (some variables in a risk assessment model cannot be precisely measure);
- model uncertainty (created for applicability in average situations, the model may not be able to simulate all realistic phenomena);
- decision-rule uncertainty (it arises because of the need to balance a variety of environmental concerns and because of difficulty in determining the degree of risk acceptance); and
- uncertainty associated with variability (using a single point risk estimate may ignore variability).

More simply, Brown and Ulvilla (1987) proposed the following two distinct types of uncertainty: outcome uncertainty, which refers to a variety of degrees of potential damages caused by a hazard, and assessment uncertainty, which refers to the probability that the results of risk estimates are likely to change. In the past, it was thought that communication of uncertainty to the public might cause public distrust in science and technology (Wynn, 1992). However, some scholars have argued that non-experts have the potential to assess risks and recognize uncertainty. Ignorance regarding communicating uncertainty might result in the public having a negative perspective of the risk management process and institutions responsible for risk assessment. Although communicating information related to uncertainty to non-experts may lower the public's perceived competence associated with organizations responsible for risk management, it could potentially increase perceived faith (John and Slovic, 1998). However, the contribution of low perceived competence to trust can be compensated by faith and honesty (Renn and Levine, 1991).

In sum, communicating information related to uncertainty might increase public trust in risk management and institutions since it is believed that non-experts are also capable of performing an individual risk assessment and conceptualizing different kinds of uncertainties. Avoidance in communicating this sort of information might create non-transparency in the whole process of environmental risk assessment, ultimately resulting in public distrust.

3.3. Idea of the study

In this study, social trust is defined as the public's reliance on the capability of public authorities and industrial agencies to provide an effective risk management measure. The study will first discuss the correlation between social trust and environmental and health concerns exhibited by lay people. Environmental concerns can be classified into the following five aspects:

- 1) psychological effects, i.e., the negative impacts of air pollutants on the human psychological system, such as anxiety or mental disorder;
- 2) physical health effects, i.e., the impact of air pollutants on the human immunity system;

- 3) respiratory effects, i.e., any respiratory diseases caused by inhalation of air pollutants;
- 4) lifestyle disruption, i.e., a negative change in local people's daily life, local customs, or tradition; and
- 5) nuisance, i.e., annoying conditions caused by the change of living environments, including, for example, noise pollution.

Next, the relationship between social trust and lay understanding of two types of uncertainties, i.e., uncertainties associated with risk assessment and uncertainty about potential impacts, is investigated. In identifying lay understanding of uncertainty associated with risk assessment, lay people's knowledge related to the cause of VOCs contamination and perceived capability of technology to prevent contamination is investigated. People who comprehend these issues are identified as being able to conceptualize uncertainty associated with risk assessment and management established by responsible organizations. In addition, to identify lay understanding of outcome uncertainty, lay people's understanding of potential factors contributing to the seriousness of health problems is explored. Based on the findings, the study will discuss the significance of uncertainty communication in increasing social trust.

4. Methodology

4.1. Study area

The Maptaphut municipality and related areas, located in Rayong Province, Thailand, was selected as a case study because of the seriousness of environmental contamination and the need for risk mitigation and communication strategies in this area. Up until 2013, there were 38 communities in the Maptaphut area. The population is 56,591 people (28,504 male and 28,087 female), and the number of households is 42,295 (MTP, 2011). Characteristics of physical environments in the area are included in Figure 1. The area contains five industrial estates which are surrounded by residential and commercial areas.

4.2. Data collection and analysis

The study employed a combination of in-depth interviews with lay people, NGOs, and public organizations' staffs, and the distribution of questionnaires to 181 people living in areas adjacent to industrial estates. The first constructed interview was conducted in March 2013. In the interviews, environmental concerns related to air contaminants and the roles of public organizations in managing risks were discussed; targeted groups were also encouraged to express their notions related to the capability of relevant organizations to provide effective risk management measures. Most importantly, issues related to the current risk communication, such as the types of messages conveyed by the government and industrial agencies, communication format, and communication frequency, were discussed with lay people. The result of the first interviews was used to design the study framework and to develop a questionnaire sheet. Then, the questionnaire surveys were carried out during October and November 2014. Each questionnaire sheet was directly handed to respondents. The questions for data collection can be shown in Table 1.

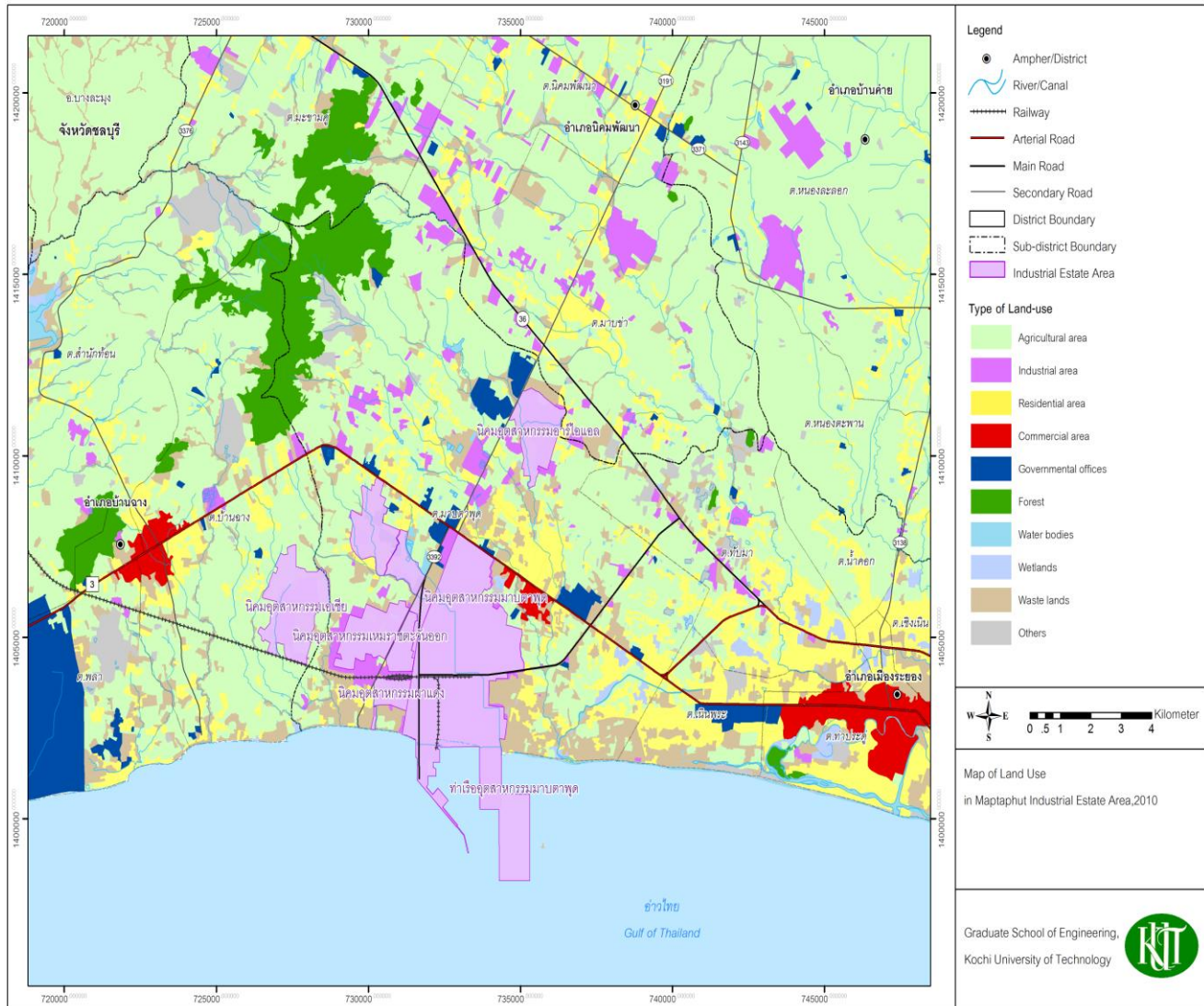


Figure 1. Study area: Maptaphut municipality and its vicinity

All collected data had been deliberately inspected and statistically analyzed by using three types of statistics. First, to demonstrate all aspects of environmental concerns exhibited by lay people, a descriptive statistic using mean and standard deviation was performed. Then, an inferential statistic using multiple linear regression analysis was carried out in order to investigate the influence of trust on lay people’s environmental concerns. In doing this, the strength of the trust variable in explaining environmental and health concerns could be demonstrated. Finally, to justify the relationship between trust and lay understanding of uncertainty, the mean score, representing a level of trust held by lay people with comprehension of uncertainty, was compared to the mean score, representing a level of trust held by lay people with no comprehension of uncertainty. The statistical difference of mean scores between groups was proven by the result of the T-test analysis. All findings were discussed in terms of their contribution to the development of strategies for public trust building.

Table 1. Factors, variables, and derived questions

Factor	Variable	Question
Environmental concerns (Potential damages caused by air pollutants)	Lifestyle disruption	Have industrial activities in the area impacted your career? As a result of industrial development, how much can you use local resources for your leisure activities?
	Respiratory effect	Has air quality in the area caused respiratory disease among residents?
	Physical health effect	Has air quality in the area caused several kinds of cancer among residents? Has air quality in the area caused disease related to self-immunity systems, such as immunity disorder, fever, etc.?
	Psychological effect	As a result of industrial development, do you feel worried about your health? As a result of industrial development, do you feel worried about your future life in Maptaphut?
	Nuisance effect	Have industrial activities caused nuisances such as noise or smells? Has the current condition of the community caused nuisances such as traffic jams, congestion, noise, smells, etc.?
Trust in public authorities	Assured reliance on capability of public authorities to provide effective risk management measures	Do you think that public authorities have the capability to prevent an occurrence of air pollutants in the area? Provided answers: (1) Not at all (2) Low (3) Medium (4) High
Trust in industrial agencies	Assured reliance on capability of industrial agencies to provide effective risk management measures	Do you think that industrial agencies have the capability to prevent the occurrence of air pollutants in the area? Provided answers: (1) Not at all (2) Low (3) Medium (4) High
Comprehension of assessment uncertainty	Understanding of causes of VOCs contamination in ambient air	Do you know how VOCs are released during the industrialization process? Provided answers: (1) Yes (2) No
	Perceived capability of technology to prevent VOCs contamination	Do you think that VOCs can be completely controlled by advanced technology? Provided answers: (1) Yes (2) No
Comprehension of outcome uncertainty	Understanding of a range of factors contributing to seriousness of health damages caused by air pollutants	Do you know which factors contribute to the seriousness of health damages caused by air pollutants? Provided answers: (1) Yes (No)

5. Results

5.1. General characteristics of respondents

The number of male respondents is slightly higher than female respondents (51.4 and 48.6%, respectively) (see Table 2). Most of the respondents are of working age; namely, respondents between the age of 30–39

and 20–29 years old occupied a major proportion of the total population, (30.4 and 28.7%, respectively). Most of them have only a high school degree, with which they are considered sufficiently eligible for several kinds of low-skilled jobs, including as construction workers and as laborers in the agricultural sector, the service sector, and the industrial manufacturing sector. The survey showed that people working in the agricultural sector and as laborers comprise the majority of the respondents (31.5%); the number of people working as an industrial staff totaled 17.1%. Considering the type of communities in relation to the degree of hazardous gas concentrations, the results of the survey showed that 70 people (almost 39%) live in moderate-risk communities, while 60 people (33%) live in low-risk communities. Respondents living in high-risk communities totaled 28.2%.

Table 2. General characteristics of respondents

General Characteristics of Respondents	Number (N = 181)	Percentage
Gender		
Female	88	48.6
Male	93	51.4
Age		
Less than 20 years old	18	9.9
20–29 years old	52	28.7
30–39 years old	55	30.4
40–54 years old	45	24.9
55 and more than 55 years old	11	6.1
Education		
Primary school	21	11.6
High school	100	55.2
Vocational degree and Associate degree	11	6.1
Undergraduate degree	44	24.3
Higher than undergraduate degree	5	2.8
Career		
Public servant	18	9.9
Laborer in agriculture sector and service sector	57	31.5
Industries' staff	31	17.1
Private company	21	11.6
Self-employment, including self-business, services, and merchants	34	18.8
Student	15	8.3
Housewife	5	2.8

5.2. Influence of trust on environmental and health concerns

5.2.1. Environmental and health concerns exhibited by lay people

The results of the surveys showed that people have high concerns regarding environment and health due to the severely contaminated air caused by the heavy industrial activities in the area. People living nearby factories were highly concerned with the impacts of polluted air on physical health, respiratory health, and nuisance; furthermore, lay people were moderately concerned with the impacts on local lifestyle and psychological health (see Table 3). Physical and respiratory health problems caused by polluted air could be recognized by the general public due to statistical records revealed in many research studies and by many relevant organizations. Besides analyzing residents' health concerns, this study placed greater emphasis on other dimensions of industrial impacts, including local lifestyle disruption, psychological health problems, and nuisance.

Lifestyle disruption: Due to the rapid change of local environments, deterioration of natural resources, and a massive migration of laborers into the area, typical local lifestyles have been gradually disrupted. For instance, lay people can no longer use their natural resources for leisure activities, such as gardening, fishing, and swimming in the sea. Furthermore, their original careers developed from local wisdom, such as rural farming and fishing, have been negatively influenced. It is generally known that the area was previously plentiful in fruit cultivation. Several kinds of delicious fruits, including mangosteen, rambutan, and durian were produced in this area; agriculture had also been a major source of income for many households. Although they did not earn a high income from agricultural farming, people could live sustainably with a balance between natural resource consumption and environmental conservation. When the air and other types of local natural resources were found contaminated, many households decided to stop operating agricultural farms, and some finally became involved in the service and industrial sectors. This phenomenon also caused diminished social interaction among people because of psychological stress and a decrease in social activities conducted together.

Psychological health problems: Since many people suffered from health problems and/or passed away without a clear explanation from responsible organizations, people have felt insecure living under the current environmental condition. Moreover, although they receive a significant amount of money from working in a factory, some people have to spend some of that money for health treatment and/or surgery. It was questioned by the public several times whether industrial development in the area could bring real prosperity to the local citizens. This situation caused public anxiety as well as psychological problems among lay people. As found in the report, the suicide rate in this area was far higher than the national average.

Nuisance: The transition from rural farming communities to urban industrial communities without proper environmental planning has also created nuisance problems. Many residential areas are situated very close to industrial plants. People could face irritation in their eyes or nose when staying nearby the plants. Furthermore, since the area became highly populated due to a massive migration, the local atmosphere, including safety, calm, and peace, has been rapidly destroyed. A lot of problems have occurred, including

traffic congestion, drug abuse, and crime. As shown in Table 3, respondents exhibited concerns related to nuisance caused by the local environmental change as high as concerns about respiratory and physical health.

Table 3. Environmental concerns exhibited by lay people

Residents' Concerns Regarding Environmental and Health Impacts of Heavy Industrial Activities		Mean*	SD.	level of concern
Respiratory health impacts	Has air quality in the area caused respiratory disease among residents?	2.71	.868	High
Physical health impacts	Has air quality in the area caused several kinds of cancer among residents?	2.77	.920	High
	Has air quality in the area caused disease related to self-immunity systems such as immunity disorder, fever, etc.?	2.82	.885	High
Psychological health impacts	As a result of industrial development, do you feel worried about your health?	2.57	.924	High
	As a result of industrial development, do you feel worried about your future life in Maptaphut?	2.40	.993	Moderate
Lifestyle disruption	Have industrial activities in the area impacted your original career?	2.24	1.152	Moderate
	As a result of industrial development, how much can you use local resources for your leisure activities?	2.36	1.059	Moderate
Nuisance	Have industrial activities caused nuisances such as noise or smells?	2.85	.853	High
	Has the current condition of the community caused nuisances such as traffic jam, congestion, noise, smells, etc.?	2.61	.934	High
* A degree of concern: 0-0.80 = no concern: 0.81-1.6 = Low concern: 1.61-2.40 = Moderate concern: 2.41-3.20 = High concern: 3.21-4 = Extremely high concern				

5.2.2. Trust and its influence on environmental concerns

One of the study hypotheses is that a degree of trust in public authorities and industrial agencies might be associated with the level of environmental and health concerns exhibited by lay people. Correlation and multiple regression were performed to examine the extent to which possibility variables of trust could predict environmental and health concerns. First, the result of the survey revealed that most people (40.3% of respondents) have moderate trust in the capability of public authorities, while 36.5% of respondents have moderate trust in industrial agencies (see Table 4). More than 47% of respondents have either low trust or no trust in industrial agencies in public authorities; approximately 45% have either low trust or no trust in industrial agencies. Overall, considering a mean score representing a degree of trust, people seem to have higher trust in industrial agencies than in public authorities.

Table 4. Trust in public authorities and industrial agencies

Level of Trust	Social Trust	
	Trust in public authorities	Trust in industrial agencies
Not at all	36 (19.9%)	32 (17.7%)
Low	50 (27.6%)	50 (27.6%)
Medium	73 (40.3%)	66 (36.5%)
High	22 (12.2%)	33 (18.2%)
Total	181 (100%)	181 (100%)
Mean/SD.	2.448/0.945	2.552/0.985

In conducting correlation and multiple regression, the scores representing a degree of environmental and health concerns in each aspect (see Table 3) were added together and calculated into a mean score. The score ranges from 0 (no concerns) to 4 (high concerns). Table 5 summarizes descriptive statistics and analysis results. As can be seen, trust in public authorities and trust in industrial agencies are negatively and significantly correlated with environmental and health concerns, indicating that respondents with high trust scores tend to have lower environmental and health concerns. The multiple regression model with two predictors produced $R^2 = 0.109$, $F(2,178) = 8.645$, $p < 0.05$. Trust in public authorities is more influential ($\beta = -0.195$, $t(178) = -2.205$, $p < 0.05$.) than trust in industrial agencies ($\beta = -0.174$, $t(178) = -1.973$, $p = 0.05$.). The regression model showed that trust could predict only 10.9% of the variance in environmental and health concerns. This can be explained by the fact that environmental and health concerns could also be predicted by other more influential factors, such as experiences, the knowledge and skill of the respondents, readiness to cope with adverse consequences, etc. However, trust still plays an important role in creating a collaborative risk management process and strengthening environmental risk communication. Without trust among stakeholders, public participation in the decision-making process as well as public support in the development of industrial activities cannot be achieved.

Table 5. Summary statistics, correlations, and results from the regression analysis

Variable	Mean	Std. Error	Correlation with environmental and health concerns	Multiple regression weights	
				b	β
Environmental and health concerns	2.604	.665	1.000		
Trust in public authorities	2.448	.945	-.299*	-0.137*	-0.195
Trust in industrial agencies	2.552	.985	-.291*	-0.118*	-0.174
*p < 0.05					

5.3. Relationship between Lay Understanding of Uncertainty and Trust

5.3.1. *The current risk communication*

According to the results of interviews conducted in March 2013 and October 2013, it was found that at least three kinds of risk information are currently communicated to lay people. The first type is information related to the characteristics of pollutants released. The types of pollutants and the amounts released in comparison with national safety standards have been announced on a daily and monthly basis by public authorities, industrial agencies as well as NGOs and educational institutes. The results of air quality monitoring are currently publicly available, and the results revealed by each organization have varied several times. This causes a lot of confusion among the public. A transparent risk assessment is, therefore, very frequently requested. The second type of information is related to diseases potentially caused by polluted air, such as respiratory disease and several types of cancer. This type of information has mostly been conveyed by NGOs and educational institutes. The last type is information related to the strategic ways to cope with polluted air. So far, no information related to uncertainty associated with risk assessment or about potential impacts has ever been communicated. This might be because of fear of the public's distrust in the competence of technology and science, as well as public contradictions in the development of industrial activities in the area. Additionally, the goal of the current risk communication mostly emphasizes informing lay people with risk information rather than the efforts to involve the public in risk management and foster mutual information sharing among parties. In this way, lay people's attitudes about risks are not considered in risk management processes.

5.3.2. *Relationship between lay understanding of uncertainty and trust*

Regarding the research hypothesis, the study assumed that under the current risk communication in which people are poorly communicated with regarding information related to assessment uncertainty and outcome uncertainty, people who are able to conceptualize uncertainty might exhibit lower trust than people who are not able to conceptualize uncertainty. This is because of the low perceived transparency in risk assessment and the low perceived honesty of the relevant institutions. The result of the analysis showed that almost 60% of respondents recognized uncertainty associated with risk assessment and management. They believed that an advanced technology cannot entirely eliminate risks associated with industrial activities; however, almost 40% of respondents are confident in the capability of an advanced technology to entirely eliminate such risks (see Table 6). In addition, 40% of respondents understood how VOCs are possibly released into the ambient air (see Table 7). People can understand the possibility of VOCs contamination as well as the limitations of technology in managing risks. In fact, no matter how effective risk management is, it will continue to be associated with uncertainty for several reasons, including human or mechanical errors, weather conditions, and natural disasters. In addition, the results of the survey also showed that about 60% of respondents could understand outcome uncertainty (see Table 8). Namely, those people have understood a number of factors potentially contributing to varying seriousness of diseases, such as self-immunity systems, the amount of

compounds which entered the body, and genetic characteristics. Therefore, it could be stated that most people, i.e., at least 60%, could conceptualize both assessment uncertainty and outcome uncertainty.

To understand relationship between lay understanding of uncertainty and the degree of trust in public authorities and industrial agencies, test of variances and t-test analysis were performed. It was found that degrees of trust in public authorities and industrial agencies are significantly different between people who recognized and those who did not recognize assessment uncertainty. As shown in Table 6, the 105 respondents that recognized technological uncertainty and the 72 respondents that did not recognize technological uncertainty demonstrated a significant difference in levels of trust in public authorities; as expected, people recognizing uncertainty exhibited lower trust. Similarly, respondents that recognized technological uncertainty also had lower scores of trust in industrial agencies than those that did not recognize this type of uncertainty. The result illustrated in Table 7 is similar to that in Table 6; namely, people that can comprehend the causes of VOCs contamination have significantly lower scores of trust in public authorities than those who could not comprehend the same issue. Scores of trust in industrial agencies were also significantly different between people with comprehension and no comprehension of the causes of VOCs contamination.

Considering the effect of lay understanding of outcome uncertainty on levels of trust in public authorities (see Table 8), there was also a significant effect for respondents in terms of recognizing and not recognizing outcome uncertainty, with recognizing respondents giving relatively lower scores than unrecognizing respondents. The result also indicated that scores of trust in industrial agencies are not significantly different ($t [179] = 1.093, p = .276$). No matter whether respondents did or did not recognize outcome uncertainty, scores of trust in industrial agencies were not significantly different. It could be explained that industrial agencies do not have a direct responsibility to provide residents with health care services, and thus lay people do not rely on industrial agencies.

Overall, the results demonstrated that lay understanding of both types of uncertainties had a significant effect on trust in public authorities. Only lay understanding of assessment uncertainty significantly influenced trust in industrial agencies; lay understanding of outcome uncertainty did not have an effect.

Table 6. Summary statistics, and results from the t-test analysis

	comprehension of assessment uncertainty (technological uncertainty)			no comprehension of assessment uncertainty (technological uncertainty)			T-test			Test of Variances	
	N	M	SD.	N	M	SD.	t-value	df	Sig. (2-tailed)	F	Sig
Trust in public authorities	105	2.352	0.951	72	2.667	0.872	2.234	175	.027	2.051	.154
Trust in industrial agencies	105	2.448	0.940	72	2.792	0.978	2.353	175	.020	.000	.998

Table 7. Summary statistics, and results from the t-test analysis

Trust	comprehension of assessment uncertainty (causes of contamination)			no comprehension of assessment uncertainty (causes of contamination)			T-test			Test of Variances	
	N	M	SD.	N	M	SD.	t-value	df	Sig. (2-tailed)	F	Sig
Trust in public authorities	71	2.028	1.000	110	2.718	.803	4.887	126.36	.000	5.081	.025
Trust in industrial agencies	71	2.296	1.074	110	2.718	.890	2.758	129.40	.007	7.296	.008

Table 8. Summary statistics, and results from the t-test analysis

Trust	comprehension of outcome uncertainty			no comprehension of outcome uncertainty			T-test			Test of Variances	
	N	M	SD.	N	M	SD.	t-value	df	Sig. (2-tailed)	F	Sig
Trust in public authorities	107	2.271	.927	74	2.703	.918	3.092	179	.002	.429	.513
Trust in industrial agencies	107	2.486	0.965	74	2.649	1.013	1.093	179	.276	.172	.679

6. Discussion

6.1. Roles of trust in forming environmental and health concerns

Consistent with previous studies (Slovic 1993; Frewer et al., 1996; Duan, 2005), the result showed that lay people's trust in public authorities and industrial agencies was not high. The more people have real experiences in facing air pollution or chemical accidents, the more trust in public institutions and industrial agencies can be destroyed. In the case of Maptaphut, besides the chemical odor that people frequently smell, chemical accidents have also happened quite often (Decharut and Penchom, 2005). This situation potentially gives rise to the destruction of public trust. The study also found that public trust has a reverse relationship with environmental and health concerns held by lay people; however, its strength in predicting environmental and health concerns was low. It is possible that people in the area have become more knowledgeable and thus they do not need to rely on relevant institutes. As Siegrist and Cetkivich (2000) observed, people who have insufficient knowledge about risks will tend to rely more on social trust when making judgments about risks. Similarly, Vikund (2003) noted that the size of the correlation between social trust and environmental concerns was huge if the level of knowledge about risks reported by people was low.

In addition, Duan's (2005) comparative study on environmental risk perception and social trust between US and China also demonstrated that social trust could predict only 2% of the variance of perceived environmental risks held by American respondents; however, it could not predict risk perception held by Chinese respondents at all. The study concluded that the level of knowledge might influence the size of correlation since American respondents had reported a lower level of knowledge related to environmental risks than that reported by Chinese respondents. Besides the level of reported knowledge that influences the correlation size, the type of environmental risks is also immensely influential. As addressed in previous studies (Slovic, 1999; Viklund 2003), social trust highly influenced perceptions of risks associated with nuclear power plants, but had less influence on perceptions of non-radiation risks.

6.2. Roles of communicating uncertainty in building trust

According to the result of data analysis, most people (at least 60% of the respondents) could conceptualize uncertainty associated with risk assessment and potential damages. Those who could conceptualize uncertainty significantly have lower trust in public authorities and industrial agencies than people who could not, with the exception of lay understanding of outcome uncertainty which is not statistically related to lay people's trust in industrial agencies. This might be because people do not rely on industrial agencies in terms of receiving health protection as industrial agencies do not have any direct responsibility for providing health care. To discuss the cause of low trust in public authorities and industrial agencies among lay people recognizing uncertainty, the current risk communication was investigated. It was found that while information related to uncertainty is available to the public, it is not explicitly communicated to lay people. Most of the communicated information involved, for example, the amount of gas released on a daily or monthly basis; measurements used to protect the environment and prevent contaminations; types of potentially developed disease; and skills needed for self-protection. Avoidance of communicating uncertainty could make risk assessment and the management process less transparent, ultimately contributing to the destruction of trust (Frewer and Scatter 2007). In Maptaphut, people with comprehension of uncertainty and who have experienced real environmental pollution and are experiencing health problems might feel that risk assessments performed by the responsible institutions are not accurate and transparent. However, it has been debated in academic circles whether communicating uncertainty will be able to increase trust (Frewer and Scatter, 2007; Wiedemann et al., 2008). Johnson and Slovic (1998) suggested that communication of uncertainty can give rise to increasing institutional honesty, but that doing so will also probably minimize the level of competence perceived by the public. Frewer et al. (2002) found that public distrust occurred because of institutions' failure to properly communicate information related to uncertainty to the public. People tend to accept uncertainty caused by insufficiency of scientific knowledge rather than uncertainty caused by a failure of the relevant organizations to minimize scientific uncertainty (Frewer et al., 2003).

To enhance public trust in capability of public authorities and industrial agencies to manage risk, this study suggests two aspects. First, information related to assessment uncertainty and outcome uncertainty should be included in risk communication. Communicating uncertainty can show transparency in risk management and willingness to consult with the public, thereby potentially leading to greater institutional

credibility and trust. Honesty and openness are important components of trust building. Though, communicating uncertainty might decrease the public's perceived competence in risk management, the contribution of low perceived competence to trust can be compensated by faith and honesty of institutions. Therefore, information related to outcome uncertainty (types of potentially developed diseases in relation to genetic characteristics), uncertainty associated with environmental risk assessment (limitation of scientific knowledge in measuring contaminations or emissions or limitation of technology in controlling emissions) should be clearly explained when risk communication is conducted. In addition, how uncertainty is managed and controlled by responsible organizations should be emphasized as well. Second, to effectively communicating uncertainty, collaborative communication approach should be implemented. Risk management is a task responsible by many organizations such as public health sector, industrial agencies, academia, and governmental agencies. Each type of uncertainties is well understood by a specific party, and degree of uncertainty acceptance by each party might be different. Those relevant parties should have full opportunity to express their concerns, and a final decision on the development of industrial activities under uncertainty should be made based on all stakeholders' agreement. This can lead to trust building among stakeholders.

7. Conclusion

This study demonstrated environmental and health concerns held by lay people living in a contaminated site, i.e., the Maptaphut industrial development area in Rayong Province, Thailand. Besides the potential industrial impacts on respiratory and physical health which highly concern lay people, the participants also expressed moderate concerns about local lifestyle disruption and psychological health problems, as well as high concerns about nuisance due to rapid changes in the community environments. The study also found that most people have low trust or even no trust in public authorities and industrial agencies and, furthermore, that trust has a low relationship with environmental concerns held by lay people. This is because people have become more knowledgeable, and when judging risks, they less rely on public authorities and industrial agencies. To increase the level of trust, the study investigated the role of communicating uncertainty associated with risk assessment and management as well as uncertainty about potential impacts. It was found that respondents (almost 60%) could conceptualize assessment uncertainty and outcome uncertainty, and these same respondents exhibited relatively lower trust than people who did not recognize the uncertainties. The study suggested that since most people could recognize uncertainty, information related to uncertainty should be explicitly and carefully communicated to the public. At the very least, doing so can increase the transparency of risk management and show the institution's willingness to consult with the public, thereby leading to greater institutional credibility and trust. In addition, to effectively communicating uncertainty, collaborative communication approach should be implemented as each type of uncertainty is well understood by a specific party. A degree of uncertainty acceptance by each party might be also different. Those relevant parties should have full opportunity to express their concerns, and a final decision on the development of industrial activities under uncertainty should be made based on all stakeholders' agreement. This can lead to trust building among stakeholders.

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Appendix

The Result of Regression

Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	3.239	.144		22.462	.000
Trust in public authorities	-.137	.062	-.195	-2.205	.029
Trust in industrial agencies	-.118	.060	-.174	-1.973	.050
R = 0.330, R ² = 0.109, Adjusted R Square = 0.099, Std. Error = 0.631, Durbin-Watson = 0.987 The mean difference is significant at 0.05					

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	7.050	2	3.525	8.645	.000 ^b
Residual	72.577	178	.408		
Total	79.627	180			

Descriptive Statistics			
	Mean	SD.	N
Risk Perception	2.604	.665	181
Trust in public authorities	2.448	.945	181
Trust in industrial agencies	2.552	.985	181