Protection Against Air Pollution

Which Factors Influence Self-protection and Environmentally Friendly Behaviour Against Urban Air Pollution in Taiwan

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Executive Summary: In Taiwan, little is known about the socio-behavioural drivers of self-protective behaviours against urban air pollution, nor the socio-spatial context in which they take place, hampering effective risk communication. The current study first assessed the socio-spatial context of air pollution in Taiwan, to then test a newly developed health-behavioural model predicting self-protective and environmentally behaviour among urban residents in Taipei, Taichung and Kaohsiung. Findings of a qualitative data analysis indicated that despite decreasing trends of urban air pollution since the early 2000's, national air quality standards are often not met and health risks are still severe. Although a direct relation between neighbourhood socioeconomic status (SES) and health risk could not be assumed, those employed in heavy industry, children and aboriginal Taiwanese were found to be at increased risk. Additionally, findings indicated Kaohsiung having worse air quality and lower average SES than Taichung and subsequently Taipei, resulting in increased public health risk from urban air pollution. This discrepancy has several socio-political, economic and climatological drivers, and was described by respondents as the North-South divide. Despite growing governmental efforts to abate air pollution, public concern in Taiwan has spurred from 2011 onwards. A self-organized grassroots movement has increasingly mobilized the public in both offline and online platforms. Respondents indicated residents in Taichung being more concerned and involved than those in Taipei and subsequently Kaohsiung. Then, to test the proposed behavioural model, a survey was conducted yielding 699 participants in Taipei, Taichung and Kaohsiung combined. Findings of statistical analyses indicated Taiwanese urban residents are more highly concerned about air pollution than found in other studies, and the developed model was partially supported. Age, feeling self-efficacious, having high perception of risk severity, reliance on governmental information sources and personal health experiences predicted self-protective intentions, whereas outcome efficacy and other demographic variables did not. In turn, self-efficacy, perceived positive outcomes, environmental risk perception and governmental trust predicted environmentally friendly intentions to abate urban air pollution. Respondents from the three cities also differed significantly in their personal experience, risk perception, governmental trust and behavioural intentions, suggesting Kaohsiung residents being less concerned about urban air pollution than those in Taichung and Taipei. Further theoretical and practical implications are discussed, and recommendations for further research are suggested.

Key words: ambient air pollution, self-protective behaviour, burden of disease, environmentally friendly behaviour

Abbreviations

ACT	Air Clean Taiwan
COPD	Chronic obstructive pulmonary disease
CVD	Cardiovascular disease
EPA	Environmental Protection Administration
FGD	Focus group discussion
HAPA	Health action process approach
MRA	Hierarchal multiple regression
NGO	Non-governmental organisation
PADM	Protective action decision model
PCA	Principal component analysis
POB	Pro-environmental behaviour
PM2.5	Fine atmospheric aerosol particles, with a diameter of 2.5 μm or less
PM10	Coarse atmospheric aerosol particles, between 2.5 and 10 μm
RISP	Risk information seeking and processing model
ROC	Republic of China, Taiwan
SARS	Acute respiratory syndrome
SES	Socio economic status
WHO	World Health Organization

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1. Introduction

1.1 Ambient Air Pollution

Globally, ambient air pollution is one of the largest environmental causes of disease and premature death in the world (Landrigan et al., 2017). In 2015 alone, ambient particle and ozone air pollution caused a combined 4.5 million deaths, accounting for 5.4% of all deaths worldwide (Landrigan et al., 2017; Prüss-Üstün, 2016). We define ambient air as the gaseous mixture surrounding the earth. Pollution can be broadly "defined as unwanted, often dangerous material that is introduced into the Earth's environment as the result of human activity, that threatens human health, and that harms ecosystems" (Landrigan et al., 2017, p. 7). As such, ambient air pollution refers to the uptake of hazardous materials into the air. The World Health Organization (WHO, 2014) has distinguished particulate matter (PM: e.g. PM2.5 and PM10), ozone, nitrogen dioxide and sulphur dioxide as the most relevant pollutants in regard to human health. The most notable sources globally include fuel combustion from motor vehicles, heat and power generators, industrial facilities, municipal and agricultural waste management and residential activities using polluting fuels (e.g. wood stove). Because of rapid urbanization and industrialization trends seen around the world, air pollution is becoming increasingly an issue in urban centres (Karl & Trenberth, 2003; Landrigan et al., 2017). Because the study of indoor and outdoor air pollution require greatly different approaches, for simplicity, the current study refers to air pollution as the combination of ambient air pollution and ozone pollution, excluding indoor air pollution, .

1.2 Climate and Health Impacts

Many air pollutants, such as ozone and nitrogen oxides, can also act as potent greenhouse gases. Although often seen as a local issue occurring especially in megacities, air pollution transports across continents and ocean basins. Therefore, air pollution acts as a driving force of climate change, with regional and global consequences (Karl & Trenberth, 2003; Ramanathan & Feng, 2009). The most widely discussed impact of urban air pollution is however, on human health.

Air pollution, especially fine particulate matter, has been associated with a broad array of acute and chronic illnesses. For example, an estimated 14% of global lung cancer cases are attributable to ambient air pollution (WHO, 2014). Other diseases related to ambient air pollution are chronic obstructive pulmonary disease (COPD), myocardial infarction, acute bronchitis and a range of other cardiovascular and pulmonary diseases (WHO, 2014; Prüss-

Üstün, 2016). If no effective measures are taken, the number of ambient air pollution related deaths is set to increase by more than 50% by 2050. However, the largest increase is likely to occur in south and east Asia, while the highly industrialized Western countries have reduced the burden of disease from ambient air pollution (Landrigan, 2017; Lelieveld, Evans, Fnais, Giannadaki & Pozzer, 2015).

1.3 The Inequality of the Burden of Disease

Already today, the burden of disease is not spread equally throughout the world, as the greatest numbers of deaths from air pollution occur in rapidly developing and industrialising lower to middle-income countries, such as China, India and Bangladesh, especially in larger urban areas (Landrigan et al., 2017; WHO, 2014). In China, a country especially challenged by ambient air pollution, fewer than 1% of 500 cities examined meet air quality standards recommended by WHO (Zhang & Crooks, 2012; Sun, Kahn & Zheng, 2017). Not only does air pollution impact physical health, it also affects mental health, and leads to detrimental productivity losses and other economic damages (Tzivian et al., 2015; Landrigan et al., 2017). Despite these negative impacts on individuals and societies, the largest proportion of ambient air pollution comes from anthropogenic sources, especially in urban areas (WHO, 2014).

On top of this, the effects of climate change, as a result of air pollution, are generally felt more in developing countries than in those highly developed. Global temperature rises due to human induced emissions continue to expose humans to disease and other climate related health threats. Spread of for example malaria, diarrhoea, malnutrition and flooding inland flooding related fatalities occur mostly in developing regions (Patz, Gibbs, Foley, Rogers & Smith, 2007).

1.4 Does Individual Action Matter?

The effects of urban air pollution can be seen as a collective social trap, referring to a situation in which actions that serve the self-interest slowly create long-term negative impacts for the collective. Yet, backing out of the behaviours has become difficult (Platt, 1973). For example, using motorized vehicles can greatly improve a person's quality of life, or a company's efficiency. However, as more people start driving, hazardous exhaust fumes start to accumulate, creating considerable air pollution, impacting health and ecosystems (WHO, 2014). However, by the point the negative health impacts become apparent, reducing one's driving behaviour may be perceived as too costly (Skov, Cordtz, Jensen, Saugman, Schmidt & Theilade, 1991).

Governmental action is needed to effectively decrease urban air pollution, for example through congestion charges and emission regulations (Landrigan et al., 2017). However, in addition to this top-down approach of tackling air pollution, the way individuals perceive and react to air pollution is also highly relevant for tackling air pollution. One individual strategy that may be highly relevant, is taking self-protective measures. Generally, protective behaviours have been defined by Burton, Kates and White (1993) as both intentional and unintentional actions aimed to decrease risks caused by extreme events within the natural or social environment.

Self-protective behaviour can be seen as a form of pro-environmental behaviour (PEB), and comprised of a mixture of two types of actions: self-interest actions and actions based on concern for other people, generations, species or ecosystems (Bamberg & Moser, 2007). Related to urban air pollution, "citizens" protective behaviour can also be classified into two categories according to PEB: self-protective actions and environmentally friendly actions. Citizens can take actions to reduce exposure to city smog (e.g., wear breath masks, stay indoors during smog events, use air filters and maintain clean sanitation), and they can also alter their own lifestyle in order to reduce smog emissions (e.g., reduce car use and save resources)" (Cheng, Wei, Marinova & Guo, 2017, p. 247). As such, the former is beneficial only to the self, whereas the latter has an environmental impact, but does not provide direct personal protection. Within the context of personal action, collective action and supporting governmental action can also serve the goal of improving air quality (Lubell, Vediltz, Zahran & Alston, 2006; Wakefield, Elliot, Cole & Eyles, 2001). Antecedents of these behaviours are for example demographic factors, perceived risk, attitudes, perceived vulnerability and feeling efficacious to perform the needed action (Cheng et al., 2017; Sim, Moey & Tan, 2014; Xu, Chi & Zhu, 2017).

Public perceptions and protective behaviour in relation to urban air pollution has been widely reported, especially in cities in Western Europe, the United States of America (USA) and People's Republic of China. However, local context plays an important role in public perception and adoption of smog protective behaviours (Wei, Zhu, Marinova & Wang, 2017; Xu, Chi, Zhu, 2017). Furthermore, as cities in south and east Asia are likely to be hit hardest by the effects of air pollution, the context of multiple countries or sub regions may be relevant in order to effectively influence protective behaviour. In the current study, Taiwan has been chosen as a case study, focussing on city air pollution, its' socio-economic context and personal behavioural responses. Air quality is well monitored in Taiwan, and its relations to human health well documented. Furthermore, Taiwan was chosen because of its high level of governmental action to both abate air pollution itself, as well as promote protective behaviours among the general public. For example, a mobile app was launched in 2013 that provides users with real time air quality information and subsequent behavioural advice (see figure 1).

Figure 1. Example of Environmental Info Push Application, by EPA

1.5 Research Aim

To our knowledge, no empirical work has assessed individual action to combat air pollution within the Taiwanese context. During an outbreak of acute respiratory syndrome (SARS), knowledge, regional differences and several demographic factors were predictive of wearing surgical facemasks as a form of self-protection in Taiwan (Sim, Moey & Tan, 2014). This indicates that different factors influence self-protection among the Taiwanese public, which could generalize to the case of air pollution. Yet, people's knowledge, perception and behaviour in response to air pollution events have to date not been assessed. Additionally, it is currently unknown how the general public of Taiwan responds to the air quality situation. Untangling these relationships is an important step in developing effective interventions to promote self-protective actions among the general public (Bickerstaff & Walker, 1999). This is important on several levels. Stimulating self-protective behaviours will increase public health and well-being levels, as it decreases the health risk of air pollutants. Additionally, individual actions such as switching to a green mode of transport can help abate the accumulation of local smog incidences, especially in urban areas, resulting in cleaner cities. In light of the current knowledge gap, the current work addresses the following research question:

Which socio-behavioural factors influence intentions to perform self-protective and environmentally friendly behaviours against air pollution among Taiwanese urban residents, given different socio-spatial circumstances?

First, a literature review will describe the current body of knowledge on air pollution, within the social sciences domain. Based on this review, a research design will be elucidated, guiding the current research methodology. Then, two chapters will describe the methodology and results of subsequently a qualitative analysis of urban air pollution in Taiwan, and a quantitative analysis of self-protective behaviour among a Taiwanese urban sample. The most important findings, as well as limitations, are described in the discussion chapter, followed by some concluding remarks.

2. Theoretical Framework

This study will start by assessing the role of socio-economic development on susceptibility to air pollution, as this is relevant within the context of development studies. Then, relevant theories are discussed on how people perceive city smog, and react to it. After assessing the most relevant theories, a new behavioural model will be proposed and tested within the context of Taiwan.

2.1 Susceptibility to air pollution

Globally, air pollution related deaths are most prevalent in rapidly developing and industrializing lower- to middle income countries. However, the poor and marginalized are disproportionately affected in any country, as well as young children and the elderly (Landrigan et al., 2017). In the USA for example, several studies found persons with a lower SES were more likely to be exposed to air pollution, suggesting socio demographic groups in the USA experience air pollution unevenly. As such, especially the young and elderly, people with low income and from minority communities were likely to be hit hardest (Bell & Ebisu, 2012; Clark, Millet & Marshall, 2014; Miranda, Edwards, Heating & Paul, 2011). This pattern was also found for neighbourhood SES in many American cities, where pollutant concentrations were lower as neighbourhood SES increased (Hajat et al., 2013). In Europe however, this pattern seemed to mixed. Although the limited number of studies in New Zealand, Asia and Africa did show a similar pattern to the USA (Hajat, Hsia & O'Neill, 2015). In addition to being disproportionately at risk, income inequality can also exacerbate exposure through limiting self-protective options. In China, a study by Sun et al. (2017) found households to be more likely to invest in masks and home air filter products after ambient air levels deteriorated. However, participants with higher incomes were more likely to invest in air filter products, which are both more expensive and effective, than face masks.

In large urban areas, income disparity can exacerbate air pollution exposure through mobility. Mobility rates (trips/day) generally increases with income, paralleled with use of motorized transport, although this pattern is affected by transport policies, relevant costs (parking, gas, etc), availability and convenience of the transport mode (Desai & Potter, 2013). As such, for those who do not have access to motorized transport, commuting may lead to higher exposure to air pollution, as enclosed vehicles offer protection against air pollutants, and generally decrease exposure time through increased travel speed. Furthermore, as air pollution in urban areas often concentrates near large roads, those who spend more time outside are more affected. For example, a study in Bangkok, Thailand, found street vendors were more exposed to fine air particles than participants with indoor activities (Ruchirawat, 2005). The findings exemplify the inequitable exposure to air pollution among groups and areas of different SES and professions, which could be relevant for the extent to which people are able to protect themselves against air pollution. Furthermore, national and local governance can both alleviate or exacerbate these issues through setting policies and laws, such as stimulating public transport systems and removing pollution industries (He, Huo & Zhang, 2002; Véron, 2006). For example, the 2003 congestion charging scheme in central London have positively contributed to ambient air quality in the greater London area (Atkinson et al., 2009; Beevers & Carslaw, 2005). Additionally, engaging the public through 'participatory modelling' has become more popular in recent years, where lay understandings are used through for example mapping of local knowledge about air pollution and related issues (Yearley, Cinderby, Forrester, Bailey & Rosen, 2003). In addition to these external factors, internal factors, such as people's individual interpretations and cognitions, can influence whether a person will protect themselves against air pollution.

2.2 Attitudes Toward Air Pollution

An important facet of people's interpretation of, and reaction to air pollution is personal attitudes. An attitude can be operationalized as a response to an antecedent stimulus or attribute object (Breckler, 1984). An attitude is comprised of several distinguishable, yet interrelated components, namely cognition, affect and behaviour (Breckler, 1984; Jacobs, 1981; Ostrom, 1969). Relating to air pollution, in a qualitative study Xi et al. (2017) have distinguished several important components, namely knowledge and beliefs, perceptions and concern and behavioural responses.

2.2.1 Knowledge and beliefs.

A first attitudinal component is knowledge and beliefs, which relates to the cognitive appraisal of air pollution. Across sociodemographic and geographic scales, the general public seems to be aware of air pollution to some degree. A study in Beijing for example, found that fewer than 3 percent of respondents had never heard of city smog (Wang, Sun, Yang & Yuan, 2016). Yet understanding of the major sources of air pollution seems to remain variable. This could partially be due to the locally variance in air pollution sources. Additionally, unlike the scientific community, the public often uses sensory cues such as sight and smell, to assess air quality (Bickerstaff & Walker, 1999; Evans et al., 1988; Xi et al, 2017). Furthermore, although people often have no trouble in naming the sources of air pollution in their locality, knowledge on how and to what extent the source contributes to air pollution is often limited (Liao et al., 2015).

Knowledge that exposure to air pollution has negative health impacts in general and for the self seems to be high across samples in for example China, Iran and the USA, although in a low income, low educated neighbourhood in Kenya, only half of respondents associated air pollution with health risks, indicating that sociodemographic factors, SES and the consequent access to information may play an important role in knowledge (Evans et al., 1988; Huang & Yang, 2017; Mohammadkhah et al., 2017; Ngo, Kokoyo & Klopp, 2017; Xi et al, 2017). Furthermore, being a parent under 40, having international travel experience and having higher education also predicted more awareness of air pollution in a Nanchang, China, sample (Liao et al., 2017).

Nevertheless, knowledge on environmental impacts has been understudied. Xi et al. (2017) reported that the impacts of air pollution on ecological systems was not mentioned by any respondent. This need not be surprising, as dealing with a complex scientific issue, such as climate change, presents cognitive difficulties and acquires more intense use of cognitive tools (Lewandowsky, 2016). An important factor that seems to shape knowledge of the impacts of air pollution, is personal experience (Skov et al., 1991; Xi et al, 2017). However, optimism bias has been reported when asking people about their personal health risks from air pollution (Xi et al., 2017). A study in China found for example, that respondents who were continuously exposed to air pollution judged themselves as being at lower risk, than those who were only periodically exposed (Wei et al., 2017).

2.2.2 Perceptions and concern.

In contrast to knowledge and beliefs, perceptions and concern are mainly comprised of affective appraisal, which can be accompanied by cognitive appraisal. To assess air quality, the public generally seems to rely on sensory cues to make indications (Bickerstaff & Walker, 1999; Evans et al., 1988; Xi et al., 2017). Other factors affecting public perceptions of air quality are place identity, ease with which one can imagine air pollution and the halo effect, meaning that people have a tendency to think air quality in their own neighbourhood is better than in other neighbourhoods (Xi et al., 2017).

Although knowledge of air pollution is often high, concern has not been found generally high across studies, although affective concern and cognitive awareness have been found to be positively correlated (Swan, 1970). A study in Beijing found around two thirds of participants to be either slightly concerned or not concerned about the health effects of air pollution at all

(Xi et al., 2017). In a similar vein, Rotko (2004) found about 40% of a Helsinki sample to be highly concerned about air pollution, although there seemed to be a crowding out effect from other environmental issues. Personal health experiences generally seem to increase concern about air pollution (Skov et al., 1991; Xi et al., 2017). However, several other factors have been found to alleviate concern about air pollution. A feeling of uncontrollability or powerlessness may decrease concern (Cheng, Wei & Ge, 2017; Xi et al., 2017). In addition, perceiving benefits of the place of residence may offset the concern about local air pollution, as well as not being able to relocate to a less polluted area (Xi et al., 2017). This could indicate that people either accept their situation, or showcase denial, also found by Evans (1988). Interestingly, Wei et al. (2017) found respondents of a Chinese city with high air pollution risk to have significantly lower levels of risk perception than those of a low risk city, indicating risk perception is not necessarily consistent with the objective external environment.

2.2.3 Behavioural responses.

Considered to be the most effortful component of one's attitude, behavioural responses in the wake of air pollution have been scant across populations (Cheng et al., 2017; Wei, Marinova et al., 2017; Xi et al., 2017), and Zhou et al. (2016) found for example that participants only wore facemasks during smog days to a moderate degree. This low propensity to take self-protective measures seems to be exacerbated by income disparity and other socio-demographic factors (Sun et al., 2017; Wang et al., 2016; Wei, Zhu et al., 2017). Among a Beijing sample, perceived severity, perceived susceptibility, self-efficacy, perceived barriers and ascription of responsibility were found to be important reasons for engagement in protective behaviours (Xi et al., 2017). In a similar vein, Wei et al. (2017) found respondents in a high risk city in China, who attributed responsibility for abating air pollution to individuals, to be more likely to intend on taking protective behaviours. Interestingly, this effect was reverse in a low risk city. Several of the behavioural attributes found in attitudinal research are well aligned with factors of several prominent health behaviour models, used in the field of health psychology. This indicates that using health behaviour models may be effective to describe and predict coping and protective behaviours in the wake of air pollution.

2.3 Behaviour Models and Air Pollution

Several behaviour and health behaviour models have been used in the domain of air pollution, which have overall been successful in predicting coping and behavioural outcomes. Huang and Yang (2017) used an adjusted risk information seeking and processing model (RISP; Griffin, Dunwoody & Neuwirth, 1999) to predict policy support and information seeking among a Chinese sample in regards to air pollution. Issue salience (extent to which air pollution is important, relevant and of interest) and risk perception (extent to which air pollution is perceived to pose a risk) were found to predict both policy support and seeking information about air pollution, although negative affect about air pollution only predicted policy support. Interestingly, seeking information did not necessarily lead to correct objective knowledge about the issue, indicating that the informational source can be of importance when searching for information, and then even when one finds it, it is still hard for a lay person to make sense of the information.

2.3.1 Protective action decision model.

The protective action decision model (PADM; Lindell & Perry, 1992, 2004) has been utilized to predict smog protective behaviour, both in terms of self-protective and environmentally friendly actions (See figure 2, p. 15). The PADM was originally developed in relation to people's responses to environmental hazards and disasters, and can be defined as "a multistage model that is based on findings from research on people's responses to environmental hazards and disasters. The PADM integrates the processing of information derived from social and environmental cues with messages that social sources transmit through communication channels to those at risk" (Lindell & Perry, 2012, p. 616). Cheng et al. (2017) found various smog information sources (governmental, media, peers) to be significantly related to risk perception. Furthermore, demographic factors, smog information and risk perception were found to predict respondents' intention to take self-protective measures in three different samples in China, although its link to environmentally friendly actions was weak (Cheng, Wei et al., 2017; Wei, Zhu et al., 2017). As such, the PADM provides a promising application to predict self-protective behaviour. However, the findings by Xu et al. (2017) suggest a more comprehensive, health behaviour model is needed, as findings were not completely conclusive.

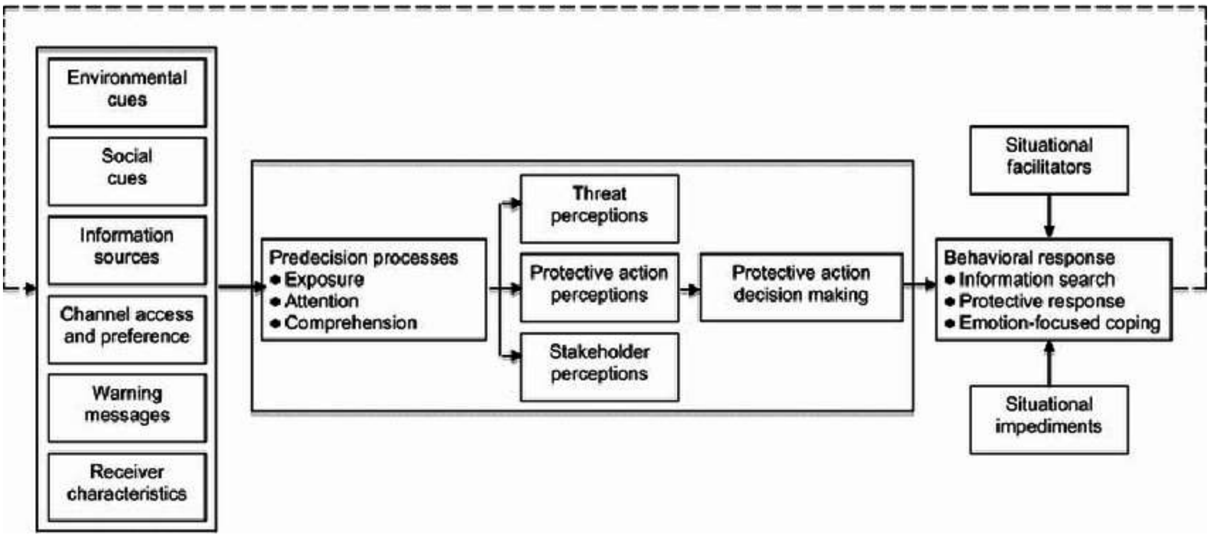

Figure 2. Flow Diagram of the Protective Action Decision Model. Copied from Lindell & Perry (2012).

2.3.2 Health action process approach.

Wearing a respiratory facemask during high pollution days in China has been found to be set in two stages (Zhou et al., 2016). During the intentional stage, self-efficacy (the extent to which one thinks they are able to perform an action), and risk perception play a role in one's intention to wear a facemask. Outcome expectancies -or outcome efficacy- (the extent to which one thinks a certain behaviour will effectively shield them from a risk) was correlated to intention to wear a facemask, but was not a predictor in a statistical model, combined with self-efficacy and risk perception. However, the authors attributed this to the two-item measure that was used. During the post-intentional volition stage, perceived action control and planning predicted actual behaviour (Zhou et al., 2016). This study was the first application of the health action process approach (HAPA), providing a multi stage, open architecture framework specifically developed to health behaviour change. See figure E for a schematic overview of the HAPA. First developed by Schwarzener (1992), its application in the context of air pollution seems promising. It was designed as an open architecture framework to predict (a) pre-intentional motivation processes and (b) post-intentional volition processes that together lead to a certain health behaviour (Conner & Norman, 2015). According to the basic model (figure E), although it has predictive power, risk perception alone is not enough to predict health behaviour. More importantly, balancing the pros and cons of a behaviour (outcome expectancies) and believing one is capable of the behaviour (action self-efficacy) are more important antecedents of forming an intention (Conner & Norman, 2015).

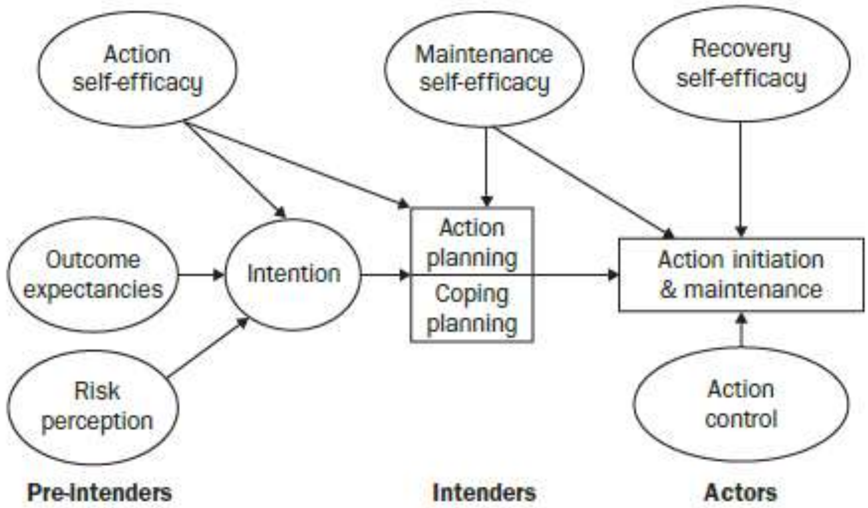

Figure 3. Flow Diagram of The Health Action Process Approach. Copied from Conner & Norman (2015).

2.3.3 Health belief model.

Although not tested within the context of air pollution, the final health behaviour model that may be relevant for the current research is the health belief model (HBM), developed in the USA during the 1950's, often attributed to Hochbaum (1958). According to the basic model, important antecedents of health behaviour are threat perceptions, behavioural evaluations and motivation, which are in turn influenced by demographic variables and psychological characteristics. Additionally, cues to action (e.g. perceiving symptoms, social influence) can affect one's health behaviour. The original model (Figure 4) does not prescribe how to operationalize the links between different variables, although behavioural evaluation is comprised of two distinct beliefs: perceived benefits and costs of a behaviour. Threat perceptions consist of perceived susceptibility to the threat, and perceived severity of the threat.

Semenza, Ploubidis and George (2011) found that threat perceptions, perceived barriers, cues to action and gender positively predicted protecting oneself against health threats of climate change among an American sample. Although air pollution risks were not exclusively measured, air quality impacts and respiratory problems were the most noted risks among the sample, indicating the HBM may be relevant. Furthermore, the attitudinal components found by Xi et al. (2017) were remarkably similar to the variables within the HBM, which alludes a promising applicability of the HBM for the current research.

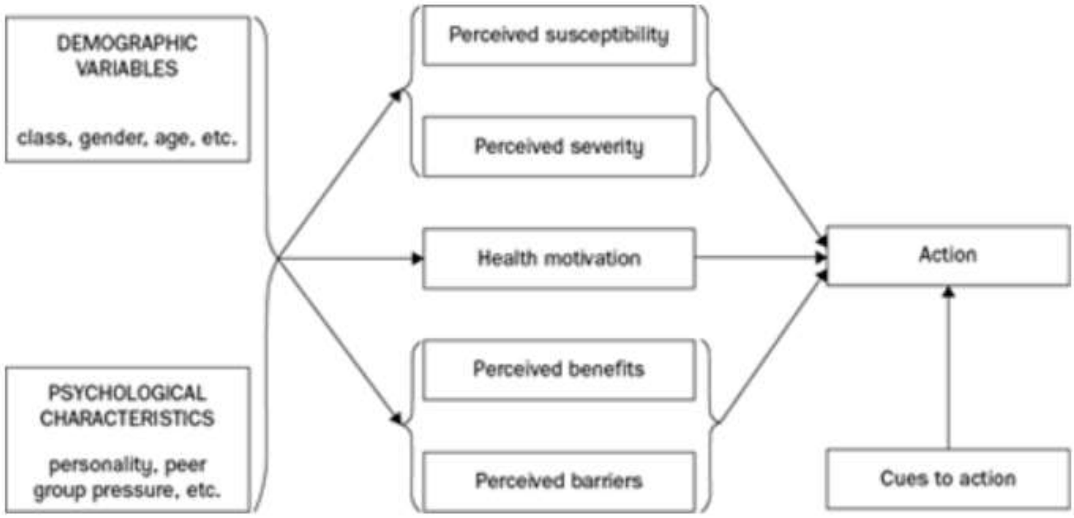

Figure 4. Flow Diagram of The Health Belief Model. Copied from Conner & Norman (2015).

2.3.4 Summary of model findings.

Based on the findings within the literature, a summary can be made of the variables that have been empirically linked to self-protection and environmentally friendly behaviour within the behavioural models, summarized in table 1. The table shows all variables that were tested for correlation and/or a causal relation, based on three different studies. For example, a significant correlation between education level and self-protective behaviour was found in the studies by Wei et al. (2017) and Cheng et al. (2017), yet the latter study did not find a significant predictive linear relation between education level and self-protective intentions.

As can be seen in the table, there are some great discrepancies between outcomes of the various studies, especially in terms of demographic variables. Outcome expectancies were found a significant predictor in the study by Cheng et al. (2017), yet not by Zhou et al. (2016), which could be due to methodological differences. Discrepancies can also be found between self-protective and environmentally friendly behaviours. Informational sources seem to be an important predictor of self-protective intention, yet not of environmentally friendly behaviours. Furthermore, findings by Cheng et al. (2017) indicated that receiving information of peers positively predicts self-protective intentions, whereas governmental and media information were merely correlated to self-protective intentions. However, receiving information of peers was not even significantly correlated to environmentally friendly intentions within the same cohort. Furthermore, findings by Cheng et al. (2017) indicated that respondents were more likely to intend on environmentally friendly actions for the sake of preventing smog from happening, than for the sake of saving resources. These discrepancies between self-protective behaviour aimed at immediate protection of the self against a certain threat, and self-protection by taking environmentally friendly actions, could indicate that environmentally friendly behaviour may follow different psychological pathways. For example decreasing one's personal car usage, which is also a self-protective behaviour, has often been related to psychological attributes such as altruism, pro-environmental attitudes and perceived social norms (Eriksson, Garvill & Nordlund, 2006; Steg, Dreijer & Abrahamse, 2005). As such, pro-environmental behaviours aimed to decrease urban air pollution can be framed both in terms of self-protective behaviour, and as environmental behaviour, of which the latter is not used in the current research.

Table 1.

Summary of variables within health-related behavioural models, tested in relation to smog-protective behaviours

Self-protective intention	
Significant result	**Non-significant result**
Income [1]	Income [2, 2]
Education [1, 2]	Education [2]
Information source [1, 2, 2]	Marital status [1]
Risk perception [1, 2, 2, 3, 3]	Age [1, 2, 2]
Self-efficacy [3, 3]	Gender [1, 2, 2]
Outcome expectancy [2, 2, 3]	Outcome expectancy [3]
	Smog experience [1]
Environmentally friendly intention	
Age [2, 2]	Gender [2, 2]
Education [2, 2]	Income [2, 2]
Information source [2]	Information source [2]
Outcome expectancy [2, 2]	Risk perception [2, 2]

Note. [1] = Wei et al (2017), [2] = Cheng et al. (2017) ,[3] = Zhou et al. (2016). If a number is not ascribed to a specific variable, this variable was not included in the study. White indicates correlation test was executed, grey indicates regression analysis was executed.

2.4 Conceptual Model

The value of combining the aspects of different social cognition models has been recognised for some time, especially if the models correspond with each other to a high degree. The constructs within the PADM, HAPA and HBM show high similarities, yet each model provides its own merits. Based on these merits and findings from studies of each individual model, the following model is proposed in the current study:

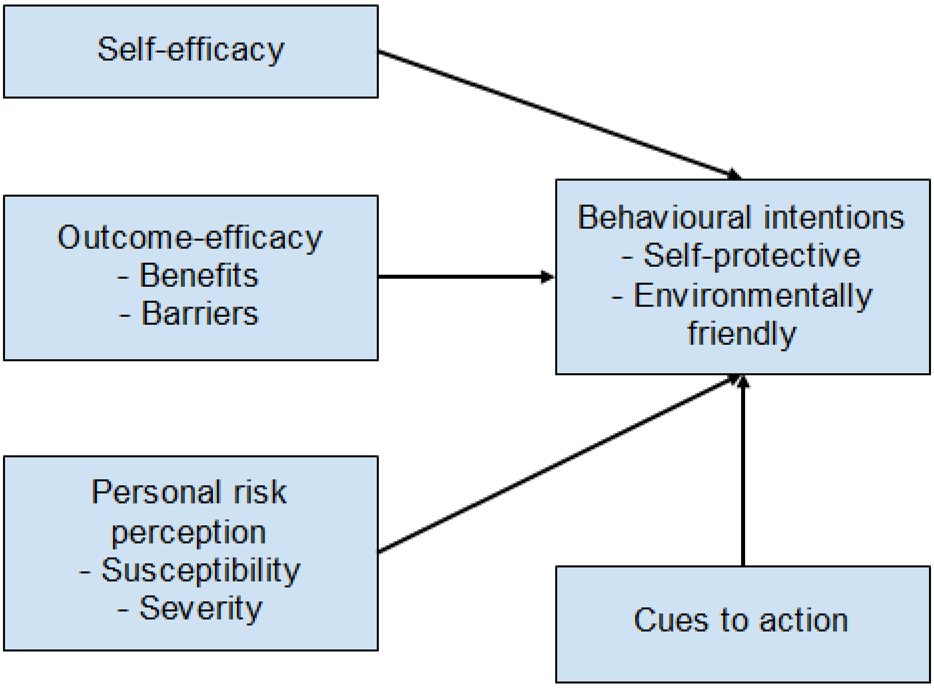

Figure 5. Proposed health behaviour model.

Within the model, self-efficacy, outcome-efficacy and personal risk perception are considered the base model, as they represent more constant constructs, in relation to cues to action, which can be seen as triggers that prompts a certain behaviour. For the current study, cues to action can be seen as personal experience with air pollution, knowledge about the issue and receiving correct information. The current study will test the merits of the proposed model.

3. Research Design

3.1 Research Questions

The current research aims to identify which factors influence people's intention to take self-protective actions during high air pollution events in Taiwan. Ultimately, this could aid intervention designers to more effectively create science-based interventions to promote self-protective actions. As such, the central question addressed in the current study will be:

Which socio-behavioural factors influence intentions to perform self-protective and environmentally friendly behaviours against air pollution among Taiwanese urban residents, given different socio-spatial circumstances?

In order to assess this central question, several sub questions shall be addressed

1. Which health risks does air pollution pose in different Taiwanese cities?
    a. Which socio-spatial differences can be identified, in terms of health risks
2. Which developments related to air pollution can be identified, within the social, economic and political context?
3. Which socio-behavioural factors can be distinguished that influence self-protective and environmentally friendly behavioural intentions against city air pollution, within a Taiwanese urban sample?
4. How do self-protective and environmentally friendly measures and their determinants differ between the public in different Taiwanese cities?

3.2 Research Aims

The current research aims to provide an exploratory assessment of self-protective behavioural responses in Taiwan. The first two questions aim to provide an overview of the adverse health effects of air pollution in Taiwan, as well as an analysis of the linkages of air pollution to the societal context, such as economic development and public concern. Although it does not test the proposed model itself, it does provide a context in which self-protective behaviour takes place, which cannot be simply gathered from the available literature. Additionally, it does provide a much needed holistic overview of air pollution as a contemporary social issue within Taiwan. To date, we have not found such an overview published in English.

Sub questions three and four address the behavioural intentions to protect oneself against air pollution, among a Taiwanese urban sample. To test whether different circumstances of air pollution severity influences protective intention, a comparison shall be made between three cities, differing strongly in their air pollution severity. This comparison will be made, as local context can greatly matter in terms of how people perceive and deal with environmental risks.

In order to answer both sets of sub questions, a widely divergent research methodology is needed. Therefore, the methodology and results sections of the current research have been divided in two sections. Chapter four will contain the methodology and results chapters that aim to answer sub questions one and two. Chapter five will contain the methodology and results chapters aimed to answer sub question three and four. The conclusion and discussion sections will provide an overarching analysis of findings, as well as a critical reflection upon the current work.

4. Air Pollution in Taiwan

4.1 Method

The aim of the current section is to provide a holistic understanding of the health threats air pollution poses in Taiwan's major cities, within the context of social, economic and political developments of recent years. As such, a more qualitative approach is suitable, using both desk-research and empirical methods. In addition to being relevant information on its own, the findings of this section can help interpreting results of chapter five, and vice versa. The current section's aims include identifying three cities that are suitable as a backdrop for the next research stages, identify which sources of air pollution are most prevalent and to discuss which forms of personal and collective action can be identified. Other topics include relevant groups that may be distinguished (e.g. local civil networks, or vulnerable groups), and socio-spatial inequalities that can be identified within different cities.

4.1.1 Desk research.

Desk research consisted of a literature search, and analysis of internal documents provided by the the Environmental Protection Administration (EPA), Executive Yuan, Republic of China (Taiwan), containing both scientific reports and internal documents and data. During literature search, Google Scholar and Pubmed were used, using search terms regarding health impacts of air pollution and socio-spatial inequalities in Taiwan or major Taiwanese cities. However, Taiwan's main academic language is Mandarin, therefore English literature was scarce. For example, all scientific reports provided by EPA were in Mandarin. However, all publications were in Mandarin. Despite these limitations, several studies were found on health impacts within the Taiwanese context. The findings based on this review were useful on their own accord, and also formed a basis for interaction with experts and civil society organizations.

4.1.2 Sampling and interviews.

A strategic sample of civil society actors and experts was drawn, identified through contacts at the National Taiwan Normal University, Taipei. A first set of respondents were approached at a public hearing about air pollution issues in Taipei, early March 2018, and then approached again for setting up interviews through email. Additional respondents were identified through personal and previous respondents' networks, and were also approached through email. See table 2 for a full list of respondents and subsequent organizational affiliations. All interviews were in English, and took place during March 2018. Participants were made aware of the purpose and topic of the research prior to starting, and were then asked for permission to record the conversation and publish their names and organizational affiliations. Respondents were asked about their thoughts and knowledge about air pollution related topics, both in general and specific to their expertise. Interviews were semi-structured, guided by a question and/or topic list made prior to each interview, leaving room for follow up questions or elaboration by participants. Important topics included for example vulnerable groups and social inequality, regional differences and the role of the public and government in abating air pollution. As more interviews were conducted, understanding of the subject grew and the question and/or topic list became increasingly detailed. After five interviews, a saturation of new information was reached. Each interview was recorded, and extensive notes were taken.

One focus group discussion (FGD) was carried out, to gain qualitative insight in layman understanding of urban air pollution, and to help interpret earlier results in light of a layman perspective. The FGD consisted of five participants, all Bachelor's students participating in an English reading group, who had not before discussed air pollution in an academic setting. The session was started with a short news video, about air pollution in Beijing. The video was chosen as it introduced the topic, yet did not give away any information about air pollution in Taiwan. Then, several assignments were used to invoke thought and discussion about the topic, such as making a wordweb, answering basic questions about air pollution, and sharing personal stories about how air pollution had affected participants.

See table 2 on p. 24.

TABLE 2.

Interviewees and Affiliated Organizations, in Chronological Order

Name/ no. of participants	Organization(s)	Role	Duration (minutes)
H.C. Chang	National Taiwan University	Assistant professor health policy and management	60
Four members of various NGOs	Air Clean Taiwan; Clean Air Taichung; Homemaker Association	Active member and/or founder	87
J.M. Yang	Air Clean Taiwan	Executive director	52
K.Y. Wei	National Taiwan University; Environmental Protection Administration	Professor geosciences; former minister	56
H.C. Hung	National Taipei University	Professor environmental management and urban disaster prevention	50
Focus group discussion, 5 participants	National Taiwan Normal University	Bachelor's students	84

4.1.3 Analysis.

Recordings were replayed to extensify written notes taken during interviews, albeit to ensure all relevant information was transliterated in verbatim. Then, notes were colour coded according to main themes (e.g. governmental actions, social inequalities, geographical differences, etc), which helped distinguish patterns in the data. Because of the relatively small number of interviews, it was possible to distil main findings without a more extensive coding scheme. Findings of the desk research, combined with interview data, provided the basis for the results below.

4.2 Results

4.2.1 Air pollution characteristics.

Table 3 shows the national annual concentrations of several relevant air pollutants. As can be seen, Taiwan has experienced decreasing trends in most air pollutants, except for O_3. Pollutant data for table 3 and Figure 7 were sourced from the department of environmental monitoring and information management, EPA. As Figure 7 shows, national PM10 levels have gradually decreased between 2005 and 2017. However, averages still exceed the WHO guidelines, set at a 20 µg/m3 annual mean, yet stay within the 65µg/m3 annual mean guidelines set by the EPA. Official EPA monitoring of PM2.5 has started in 2013. As such, annual and national data is limited. Figure 8 is based on data from a study issued by EPA, executed by the National Cheng Kung University, and shows annual means exceeding WHO standards, set at a 10 µg/m3 annual mean, as well as the EPA standard of a 15 µg/m3 annual mean. However, EPA has stated observing a decreasing trend in annual average PM2.5 levels, arriving at a mean of 20.5 µg/m3 over 2017. However, only three of Taiwan's thirteen counties have met annual air quality standards in recent years, all of which are in the less densely populated Eastern side of the island. Furthermore, as figures A and B show, average emission levels differ between Taiwan's three major cities. Kaohsiung, Taichung and Taipei were selected, as they represent the main metropolitan areas of respectively the Southern, Central and Northern parts of Taiwan. Furthermore, their roles as largest metropolitan areas results in a larger number of scholarly publications and other available data.

Figure 6. Map of Taiwan. *Note.* Sourced from Google Maps.

Table 3.

Annual Mean Concentrations of Air Pollutants

	SO_2 (ppb)	NO_2 (ppb)	CO (ppm)	O_3 (ppb)
2005	5.18	18.46	0.54	56.98
2006	4.61	18.06	0.52	59.74
2007	4.53	17.87	0.51	60.13
2008	4.35	1.9	0.47	58.47
2009	4.03	16.15	0.45	59.89
2010	4.07	16.95	0.46	57.38
2011	3.76	15.83	0.43	56.96
2012	3.29	14.64	0.43	56.36
2013	3.45	14.35	0.42	57.74
2014	3.4	14.37	0.41	58.36
2015	33	13.62	0.4	56.13
2016	2.97	13.53	0.39	53.89
2017	2.88	12.86	0.35	56.43

Note. Data sourced from EPA

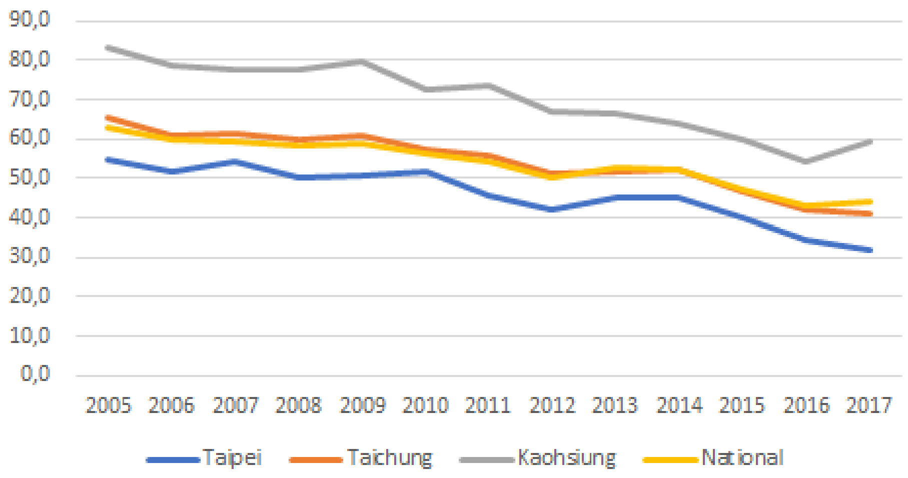

Figure 7. Annual Mean PM10 Concentration, µg/m3.

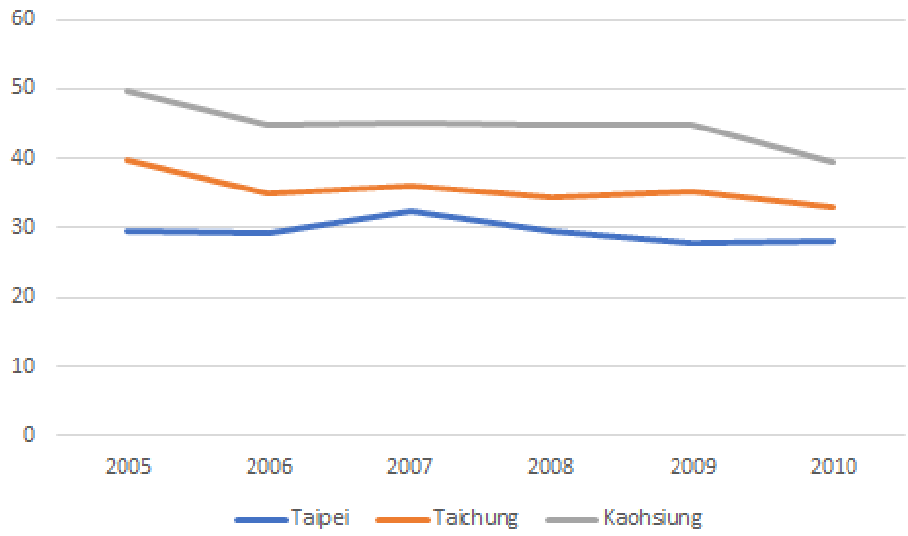

Figure 8. Annual Mean PM2.5 Concentration, µg/m3.

On a national scale, EPA estimates 34-40% of PM2.5 emissions to be attributed to sources overseas, mainly originating from mainland China. Li et al. (2017) found that, over the period of 2013-2015, the most abundant long-range transported chemical compounds were secondary inorganic aerosols (SO_2^4,NO_3, and NH_4), followed by natural crustal materials (Mg, Ca, AL, K, and Fe) and anthropogenic metals (Pb, Ni, and Zn). Under northerly wind conditions, PM2.5 concentrations were higher than under southerly wind conditions, and were most severe on the west side of Taiwan. Furthermore, the main source appointment of long-range aerosols was northern and southern China.

Of estimated domestic sources of PM2.5 emissions, 30-37% is attributed to mobile sources, with heavy duty trucks, passenger cars and transit buses having the highest impact ratios. Industrial sources account for 27-31%, mainly from oil refinery, steel industry, consumer good manufacturing and the electrical industry. Finally, other stationary sources, such as ground dust, waste burning, road dust and the catering industry account for an estimated 32-43% of annual PM2.5 emissions. In the Taichung urban area, Chio, Cheng & Wang (2004) found vehicle emissions to be the major source of PM10, followed by (sequentially) crustal materials, biomass burning, industry emissions and marine spray. During episodic events however, mainly during fall and winter, biomass burning and secondary aerosols became the most influential sources.

Locally, emissions levels are affected, and exacerbated by, economic activity, geographical location and seasonal factors. In all three cities, vehicle exhaust gasses and secondary derived aerosols are the main pollution sources. Interestingly however, in Taipei

City both population and vehicle density are highest, with 9,918 people and 6,463.87 vehicles per square kilometre respectively. Second is Taichung, with 1,249.4 people and 1,230.59 vehicles per square kilometre, and Kaohsiung having 942.22 people and 974.43 vehicles per square kilometre. This discrepancy between population and vehicle densities and emission levels in the three cities can be attributed to several factors. Industrial density increases toward the South. As such, compared to Taipei and Taichung, the Kaohsiung area has the highest density of industrial distribution, with both traditional industries (petrochemical, steel, etc) and emerging semiconductor and electronics industries. In the Taichung county, air pollutant emissions are often attributed to the non-renewable energy sector, such as the Taichung Power Plant, the largest coal-fired power station in the world. For example, Fang et al. (2010) found dry depositions of fine particles near the Quan Xing industrial park higher than in other areas near Taichung city.

In addition to the heavier environmental load related to industrial activity, geographical factors and seasonal atmospheric conditions increase air pollutant levels toward the South of Taiwan. According to K.Y. Wei (personal communication, April 2018), during the north-easterly winter monsoon (October to March), the Western side of the central mountain range acts as a leeward side. Additionally, during the north-easterly monsoon period, weak synoptic weather conditions and high-pressure peripheral circulation is more likely to occur (Hsu & Cheng, 2016). As a result, dispersion of air pollutants decreases in Western Taiwan, especially in the Kaohsiung area, leading to more high-pollution days during winter (see figure 9), a phenomenon that is well described in scientific literature (Chio et al., 2004; Fang & Chang, 2010; Hsu & Chiang, 2016; Hsu et al., 2016).

See figure 9 on p. 29.

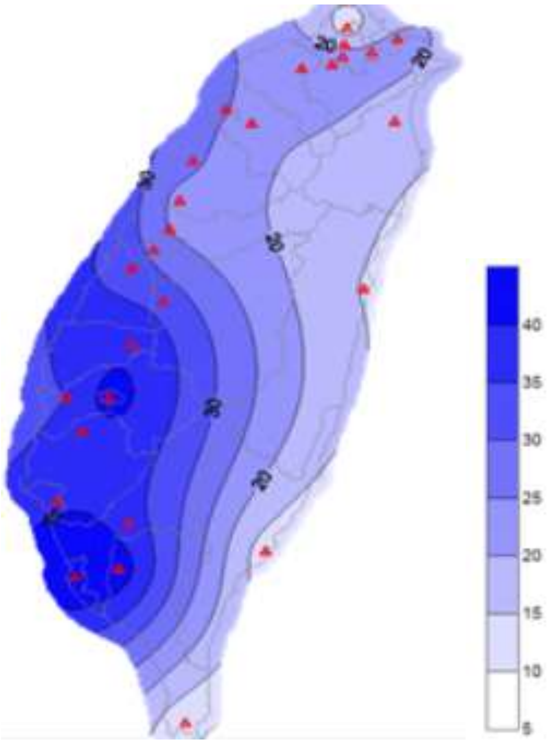

Figure 9. Average PM2.5 Concentrations During Northeast Monsoon Period
Note. Sourced from EPA. PM2.5 in µg/m3

4.2.2 Health impacts and vulnerability.

Several papers have been published in English, regarding the health-impacts of air pollution in Taiwan. In all three cities, an association was found between levels of NO_2, SO_2, PM10, PM2.5 and short term suicide levels. Although the underlying mechanisms are still unsure, it has been hypothesized that neuroinflammatory reactions play a role (Kim et al., 2018). In Taipei city, associations were found between various air pollutants and cardiovascular disease (CVD) hospital admissions. During warm days (above 20C), NO2, CO and O3 were most positively associated with increased daily CVD hospitalisation, whereas PM10 was most important during cooler days (Chang, Tsai, Ho & Yang, 2005). Similar outcomes were found in a study relating air pollution to myocardial infarction, controlling for weather, day of the week, seasonality and long-term time trends (Hsieh, Yang, Wu & Yang, 2010; Chang, Kuo, Liou & Yang, 2013). In a similar vein, a range of air pollutants were found to be positively associated with stroke admissions in Kaohsiung, both during warm and cold days (Tsai, Goggins, Chiu & Yang, 2003). In Taichung city and county, exposure to traffic related air pollutants were found positively associated with cardiovascular mortality (Tsai, Wang, Chuang & Chan, 2010). Traffic related pollutants were found to be the highest in downtown Taichung, and near highway one, situated on the western side of the city (Lin & Lin, 2002). Mode of transport can exacerbate or alleviate these effects. Another study in Taipei found PM2.5 exposure, and subsequent health impacts, were largest for those who primarily use walking as mode of transport. Using the bus or car decreased exposure, while using the subway resulted in the lowest exposure (Liu et al., 2015). However, as commuting by subway is more expensive than commuting by bus in Taipei, this could affect accessibility to low-income households.

A group that is especially vulnerable to air pollution is children. Exposure to PM10, SO_2, CO, NO_2 and O_3 was found to negatively impact lung functioning among children in Taipei (Chang et al., 2012). Exposure to air pollution in a child's residential area is significantly associated with childhood asthma, and long-term exposure to traffic related air pollutants increases a child's risk of asthma (Hwang et al., 2005). Interestingly, childhood asthma prevalence is highest in Taipei city, where vehicle combustion is the major source of air pollution (Department of Health, Executive Yuan, 1999; Lin et al., 2001). In addition to children, long term exposure to air pollution was found to changes in blood sugar, blood lipids, blood pressure and haematological markers of inflammation among a nationwide sample of elderly in Taiwan (Chuang, Yan, Chiu & Cheng, 2011). According to H.C. Chang, the Taiwanese National Health Insurance system, a centralized and compulsory insurance plan for all citizens that was instigated in 1995, has increased access to health care for all citizens. This reduces economic barriers to receive medical care for sensitive groups, such as the elderly (personal communication, April 2017).

In terms of socio-spatial differences of exposure risk, several factors play a role. Firstly, urban development of Taiwanese cities has traditionally been characterized by flexible land-use strategies, and a melting pot of building types. This is in contrast to Euro-American urban planning, in which often a strict division is made between residential, commercial and manufacturing sectors. Furthermore, in contrast to Euro-American urban development, cities in Taiwan has hardly developed economically or ethnically segregated districts (H.C. Hung, personal communication, April 2018 & H.C. Chang, personal communication, April 2018). As a result, according to H.C Hung (personal communication, 2018), neighbourhood SES will be less likely to affect exposure to air pollution.

A second factor that is of importance, is what is often described as the North-South divide of Taiwan (H.C. Hung, personal communication, April 2018; H.C. Chang, personal communication, April 2018). In general, this refers to the gap in SES between Northern Taiwan and Southern Taiwan. As H.C. Hung (personal communication, April 2018) described, the more southern one goes, the lower general education and income levels will be. For example, annual disposable income per person over 2016 was 383215 NTD in Taipei, versus 322806 in

Taichung and 304104 in Kaohsiung (based on data by the National Statistics Bureau, ROC). Taipei, as centre area, is often regarded as the hub for governance, finance and business, while the more southern counties are regarded as peripheral, focusing on manufacturing, labour and as transport hubs. As the main heavy industry is situated in Kaohsiung, citizens are more at risk of air pollution, while lower income and education levels limit their access to self-protective measures. A factor that was especially described within the Kaohsiung county was ethnic inequality. As an urban centre, Kaohsiung's labour market exerts a pull factor, resulting in a large influx of migrant workers from rural areas. Often these migrants are aboriginal Taiwanese, characterised by lower education levels. As a result, they are resolved to take unskilled labour in the heavy industry sector, increasing their exposure to air pollution (H.C. Hung, personal communication, April 2018). In 2017, the Taipei area hosted the largest number of indigenous Taiwanese citizens, versus 34,219 in Kaohsiung, and 33,903 in Taichung. However, based on the 2013-2014 period, the average indigenous population growth rate was highest in Taichung, with 2.09%, followed by Kaohsiung (1.47%) and Taipei (1.18%), all exceeding the national rate of 1.16% (based on data from Household Registration Affairs, ROC). Furthermore, according to the Taiwanese Council of Indigenous Peoples, the percentage of indigenous people working the manufacturing industry (16.05%), construction (15.82%) and agriculture (10.56%) was higher in 2017 than that of the entire population of Taiwan, while earning 10.244NT$ per month less on average (sourced from Household Registration Affairs, ROC, Taiwan).

4.2.3 Governmental policy.

Taiwan underwent rapid economic growth between the 1960's and 1990's. The high growth rates of for example population, industrial production, motor vehicles and consumer power led to an increasingly high environmental load, and deterioration of air quality (Fang & Chen, 1996). To combat these issues, the air pollution control act was proclaimed in 1975, often seen as the starting point for centralized air pollution management, and has been revised many times since. Then, the EPA was established in 1987, as the central governmental body for environmental affairs and legislation. The standards for ambient air quality and air pollution emissions have become more stringent over time. The first versions of the pollution control acts focussed on a clean fuel program (e.g. decreased sulphur content and unleaded gasoline usage), control of stationary air pollution sources (e.g. self-inspection and reporting, source permits and an enforcement task force), control of mobile sources (e.g. emissions standards and random roadside emission inspections) and control of pollution from construction sites

(Fang & Chen, 1996). However, control measures were often subordinate to economic growth, leading to a continued deterioration of air quality until the early 2000's.

Gradually, economic modernization and increasing governmental efforts have led to the decreasing trend of air pollution described in section 4.2.1. In recent years, although industrial parks have still been opened along Taiwan's western coast, a gradual shift has taken place toward development of green technology and establishment of science and innovation parks. Furthermore, a shift in the political paradigm has taken place. In 2001, the conservative Kuomintang (KMT) party lost its parliamentary majority for the first time in 50 years, to the Democratic Progressive Party (DPP). Thereupon parliamentary majority has shifted between both parties over the course of several elections. The DPP, re-elected in 2016, has put more emphasis on fighting environmental issues, which has become apparent in for example Taiwan's Green Energy Strategy (Hu & Matthews, 2016), as well as expanding the air pollution management strategy under the air pollution control act in several ways. Under the current strategy, the air quality protection plan focuses on scrutinizing air quality standards and its local evaluation and monitoring, as well as establishing a cap-and-trade system and adherence to the Montreal protocol. The strategy contains a financial incentives system for industries and the public. The stationary source control strategy has been expanded, as well as the mobile source control strategy. Furthermore, Green City and Clean Air Zone projects construe more innovative aspects of the overall strategy. Another factor that has spurred the accelerated advancement of air pollution control measures, is growing public concern.

4.2.4 Public (re)action.

According to several respondents, public concern and discourse about air pollution has spurred from 2011 onwards, when a group of medical professionals started voicing concerns about growing cases of air-pollution related disease in media outlets, based upon scientific publications and statistics made available by the EPA. Public support grew and lead to the establishment of several national and local non-governmental organizations and (social) media platforms aimed at combatting air pollution. The public movement can be characterized as a grassroots movement, who express themselves through protests, press releases and (social) media campaigns. The main aims include increasing public awareness, and pushing the governmental agenda. The largest organized group, Air Clean Taiwan (ACT), was founded by a group of physicians in 2011 in Taichung, and now has about 20 core members. According to several NGO members, activism is not yet regarded as normal behaviour for many Taiwanese, as for example explained by a member of Clean Air Taichung, and Air Clean Taiwan:

"30 years ago, we were still in martial law, so people don't really know yet that they can have their voice heard, they were taught they should not involve themselves too much in public affairs. But as more stories are spread, they (the people) start to feel more anger and fear."

Despite these limitations, public concern and media attention has grown rapidly since 2011, and new groups have emerged. Notable groups include the Homemaker Association and Clean Air Taichung. For example, since ACT launched its Facebook page in 2015, it has gained roughly 500 new followers per month. In 2017, a rally in Taichung attracted 10.000 people, and 3000 in Kaohsiung, according to NGO members. Several respondents noted that public concern has grown, because of the emerging public discourse about cancer and other pollution related diseases. For example, one respondents described a story about a Taiwanese celebrity that had never smoked getting lung cancer, which was perceived as shocking by many Taiwanese. However, despite growing concern nationwide, air pollution related NGO's were mentioned to be more active in Taichung than in Taipei and Kaohsiung, which results in more.

Despite growing attention across Taiwan, participants from the grassroot organizations indicated a North-South divide (see 4.2.2) in terms of public participation and concern. Air quality NGO's were mentioned to more active in Taichung than Taipei and Kaohsiung, where a higher frequency of for example rallies and other activities has led to a higher level of public engagement. In terms of differences between Taipei, Taichung and Kaohsiung, all respondents named Taichung as the more concerned and engaged city, whereas Kaohsiung was described as being more complacent. To explain this, firstly the role of "good citizenship" was mentioned, meaning that in Kaohsiung, and to a lesser extent Taichung, protesting is seen as something a "good citizen" would not do. In Taipei, this behaviour would be seen as something normal. Secondly, a relationship of reliance was mentioned between city residents and polluting industries, one respondent mentioned:

"In Kaohsiung, the major source of pollution is heavy industry. But many people work in this sector, so maybe people are more trapped into this."

Furthermore, company initiatives, for example coal plants donating air filters to schools, was mentioned as further increasing this relationship of dependence on the local industry. Taipei was seen as a separate case, as people were wealthier and more educated, thus having more resources, as well as having more resources allocated to by the government, as Taipei is the countries' capital.

In terms of a shared organizational discourse, the NGO movement seems highly critical of governmental efforts to abate air pollution, criticizing the central government for putting economic interests over environmental and public health. One recurring criticism during interviews, was how the central government intervened in local situations on numerous occasions. For example, by stopping local governments of impeding sanctions on polluting industries, thus protecting corporate interest. Another major criticism regards how the central government overemphasizes the role of both China and public behaviour as sources of air pollution.

In addition to these criticisms, the grassroot movement seems highly sceptical of the governmental actions. The air pollution statistics published by the EPA were not trusted by several respondents representing the NGO movement. Firstly, data from monitoring stations is corrected by the EPA before being published. This causes a delay between real time data and the data available. Furthermore, the formulas used for this correction were seen as vague, confusing and non-standardized across the country. Secondly, monitoring stations go into maintenance (meaning data is not gathered) at times that were perceived as highly suspicious, for example when there is a high pollution event. As a result, citizens have started obtaining their own data, using AirBox, a private air quality measuring device, with open source data sharing in real time. Several hundred to thousand citizens were estimated to have adopted these devices. Several NGO respondents described AirBox data and data made available by the EPA being vastly different, increasing their mistrust further. Interestingly, an unpublished study at the National Taiwan Normal University, comparing air pollution trends based on EPA data and AirBox, actually found both data sources to show similar patterns of air pollution severity.

Despite their low trust in governmental data, several respondents of NGO's indicated that citizens will believe governmental information over information published by the NGOs, albeit these conflicting messages can be confusing. This view was reinforced by FGD participants, who expressed confusion over which data is correct, amplified by the confusion about how to interpret and make sense of air pollution information in the first place. Respondents of the NGO's also indicated being scapegoated for this confusion by the government. However, despite this appearing animosity, as described by respondents from within the movement, several other respondents held more nuanced views. For example, H.C. Hung (personal communication, April 2018) indicated how the participation of academics, the public, media and NGOs in governmental activity has grown over the past 20 years. Furthermore, he indicated how a trend of privatization of government owned industry, as well as the large economic and social roles of these industries, restricts governmental actions.

In terms of effectiveness of the civil society push for air pollution control, no direct link was found to governmental action. However, responses from several interviews indicated that the involvement of civil society has pushed the EPA towards more stringent control measures and public engagement, or as one EPA employee described it:

> "We work so hard to fight air pollution, but the public is still not satisfied, so we have to do more"

As such, the critical role of the general public does seem to be a push factor for EPA policies. One of the engagement methods mentioned was data gathering by lay people. In this form of participatory modelling, citizens are provided with mobile air quality monitors which they use throughout their daily commutes. Data is collected to obtain a more in-depth and dynamic overview of air quality characteristics.

5. Behavioural Intentions

5.1 Hypotheses

The current chapter aims to test the validity of the behavioural model proposed in section 2.4. Based on the literature review, several hypotheses were drawn, relating to the behavioural model and the importance of locality. Several findings of chapter 4 were reason for further inquiry with statistical data, for example relating to the North-South divide.

- Hypothesis 1: The base model (self-efficacy, outcome expectancies and risk perceptions) predicts behavioural intention to protect oneself and take environmentally friendly measures in a positive direction.
- Hypothesis 2: The base model and cues to action jointly predict behavioural intention to protect oneself and take environmentally friendly measures in a positive direction, after correcting for demographic variables.
- Hypothesis 3: Respondents living in a high-risk city (Kaohsiung < Taichung < Taipei) differ significantly in their air pollution experience and behavioural intentions.

5.2 Method

5.2.1 Participants and procedure.

Survey data was collected from April fourth until May 13th. An online survey was spread through Facebook using MySurveyLab, with a total of 276 participants and a response rate of 17%. Several persons within the NTNU and EPA networks shared the survey link through their personal Facebook accounts, which was subsequently shared by about 10 Taiwanese Facebook users, on their own account. To extend and diversify the online sample, a paper version was handed out face-to-face in Taipei, Taichung and Kaohsiung, using various gathering techniques. These cities were chosen based on findings in chapter four, as cities represent Taiwan's three largest urban areas, yet differing substantially in terms of air pollution severity. In Taipei and Kaohsiung, respondents were randomly approached in a wide range of geographical locations throughout both cities. Locations included parks, (underground) malls, coffee shops, food courts and night markets. Both the online and paper version provided an introduction of the research, informing them about the academic nature of the research and assuring confidentiality. All participants gave informed consent before starting the questionnaire and no incentives were provided for participation. In Taichung, paper questionnaires were spread among employees and their direct acquaintances, of a large research institute.

In total 787 questionnaires were completed. However, 88 participants did not meet the criterion of residing in Taipei, Taichung or Kaohsiung, and were excluded. Of the final N = 699, 29.6% resided in Taipei, 29.9% in Taichung and 40.5% in Kaohsiung. See table 4 for an overview of participants per sampling method for each city. The average age was 34.7, SD = 12.7. 37.6% of participants was male, and 62.4% was female. Of the total sample, fewer than 1% did not have a high school diploma, 6% had a high school diploma and 9.9% had finished vocational training. Of the sample, 60.8% had acquired a university level Bachelor's degree, 20.7% a Master's degree and 2.4% a PhD. The household of participants contained on average .56 children (0-14), 2.93 adults (15-64) and .53 elderly. Compared to the national census data, the current sample was vastly more highly educated, was slightly younger and had more females. According to the national statistics bureau, in 2013 28.4% of citizens over 15 held a junior high school diploma or below, 31.5% senior high school and vocational training and 40.1% a college degree. Furthermore, in 2018 50.15% of citizens were female and 39 years on average.

Table 4.

Overview of Sample Size Per City

	Taipei	Taichung	Kaohsiung
Online version	105	88	41
Print version	101	121	243
Total	206	209	284

5.2.2 Materials.

Questionnaire

The questionnaire was first designed in English, comprising of 47 items, categorised under the factors of the behavioural model (see 2.4) and a set of demographic variables. Several questions were adapted from earlier research, namely Cheng et al. (2017), Wei et al. (2017) and Zhou et al. (2016), and new questions were developed in addition to have at least three questions for each variable. The questionnaire was translated to traditional Mandarin by a professor at the National Taiwan Normal University, and checked by three research assistants. In addition to the translation, the translation team developed a set of additional questions related to governmental policy and citizen participation, to make the questionnaire more fitting to the contemporary socio-political climate of Taiwan. The final questionnaire consisted of 59 items, and underwent final review by a senior member of the Environmental Protection Administration Taiwan before being spread. See Appendix A for the full questionnaire in English and Mandarin. Participants were asked to rate to which degree they agreed with a list of statements, most items were rated on a five-point Likert scale (1 = completely disagree to 5 = completely agree). The final questionnaire was comprised of the following categories: self-protective behaviour (5 items, e.g. *I will reduce my time spent outdoors the next time I hear of a high pollution event in my city*), environmentally friendly behaviour (4 items, e.g. *I will increase my use of public transport to cope with air pollution*), risk perception (susceptibility and severity, 12 items, e.g. *If I have to stay outside for a long time during smog days, I will risk getting a respiratory disease*), self-efficacy (4 items, e.g. *I know which measures to take to protect myself against Air pollution*), outcome efficacy (positive outcomes and perceived barriers, 7 items, e.g. *Protecting myself against smog will help me to stay healthy*), cues to action (information sources and personal knowledge/experience, 8 items, e.g. *I have had nose allergic reactions due to air pollution*), governmental policy and citizen participation (7 items, e.g. *Do you think the air pollution prevention promoted by your local government is effective?*) and demographic factors (12 items, e.g. education level, occupation and number of air filters at home). Due to an error in available categories, the variable measuring household income was rendered useless.

Underlying structure

To investigate the underlying structure of the questionnaire, data collected from the 699 participants were subjected to principal component analyses (PCA) with oblimin rotation. Prior to running the PCA, examination of the data indicated that not every variable was perfectly normally distributed. Given the robust nature of factor analysis, and the linear relationship among variables, these deviations were not deemed problematic. See table 5 for a summary of factor analyses and descriptive statistics.

A first non-forced PCA, containing all items regarding self-protective and environmentally friendly intentions, yielded consistent results with a two-factor solution. One item, namely “I intend to work or live in a city that has cleaner air”, was deleted due to a lack of correlation to the other variables. The internal consistencies of the leftover items were satisfying, with *KMO* = .80, and 60.46% of total variance explained. A non-forced PCA, containing all items regarding risk perception, self-efficacy and outcome efficacy yielded consistent results for self-efficacy and outcome efficacy, with *KMO* = .85 and 56.17% of total variance explained. Three items were deleted, as they did not meet the criteria (*Taking protective measures are too strenuous for me; air pollution does not pose any risk for me*; *If I have to stay outside for a long time during smog days, I will risk getting a respiratory disease*). Furthermore, the outcomes for risk perception items were inconclusive. Upon further examination, a three-factor structure became apparent, showing an environmental risk perception factor, in addition to the two personal risk perception factors. A forced three factor PCA corroborated these findings, with *KMO* = .85 and 66.79% of total variance explained. Lastly, a non-forced PCA without rotation, found a moderately strong underlying one-factor structure for three items related to trust in the government to effectively tackle air pollution, with *KMO* = .65 and 68.25% of total variance explained. Each variable was created by calculating the mean score of its corresponding items, this way respondents received a score for all variables on a scale from one to five. For gender and education level, dummy variables were computed.

Table 5.

Summary of Factor Analyses and Descriptive Statistics

Variable	Number of Items	Cronbach's α	KMO	Mean	SD
Self-protective intention	4	.68	.66	3.57	.76
Environmentally friendly intention	4	.84	.77	3.58	.83
Risk perception: susceptibility	3	.75	.67	3.99	.71
Risk perception: severity	4	.8	.75	3.75	.71
Environmental risk perception	3	.76	.7	4.28	.65
Outcome efficacy: positive outcomes	3	.65	.63	3.99	.72
Outcome efficacy: perceived barriers	4	.84	.75	2.26	.87
Self-efficacy	3	.73	.67	3.72	.72
Governmental trust	3	.77	.65	2.03	.76

Note. KMO statistics are based on outcomes of PCA per single factor

5.2.3 Statistical analyses.

First, means and standard deviations were calculated for all variables. Correlations were calculated to examine whether the independent variables and demographic variables showed a linear relation to the dependent variables. If variables did not show significant correlation to behavioural intentions, and no strong theoretical expectancy of a relation could be made, they were excluded from regression analyses.

To test whether the model holds a causal relation to self-protective and environmentally friendly behaviour, multiple regressions were performed. Assumptions for multiple regression were checked, followed by a set of multiple regression analyses in three steps, subsequently adding demographic factors, base predictors and finally cues to action into each analysis. Base model consisted of self-efficacy, outcome expectancy and risk perception variables. Cues to action were information sources, air quality perception, personal experience and governmental trust variables. Demographic variables were age, education and gender. The rationale behind the three-step model was twofold. Firstly, because the base model and demographic variables have been roughly tested in previous research, as such the current sample can be seen as a validation of these works. The added value of the current model is that both risk perception and outcome expectancies are split into multiple predictors, possibly giving a more detailed insight into the relations between these constructs and behavioural intentions. As exploring the predictive power of cues to action is exploratory, adding them later is preferential from a methodological point of view. Secondly, within the proposed model, cues to action are proposed to be of a more situational nature, whereas the base model is viewed as somewhat more stable. Therefore, from a theoretical perspective separating both levels would be more fitting.

To test whether respondents from the three cities showed diverging experiences of city smog and protective behaviours, several between group analyses of variance were conducted. In some cases they were one-way (ANOVA) and for some measures a multivariate analysis (MANOVA) was preferred. For example, perceived air quality was measured using one item, as such an ANOVA was fitting. Yet risk perception was measured on three different scales, making a MANOVA more fitting. Furthermore, findings from chapter 4 made several additional variables interesting for testing with ANOVA, such as governmental trust, risk perception and use of information sources. All analyses were conducted using IBM SPSS Statistics package 24.

5.3 Results

5.3.1. Descriptive statistics.

Apart from environmental risk perception and governmental trust, which showed a negative and positive skewness respectively, all variables shown in TABLE D showed a relatively normal distribution, with a slight negative skew. Participants most often relied on media sources for air pollution information (*M* = 3.3), followed by information from family members (*M* = 2.9) and information directly from governmental sources (*M* = 2.6).

79.2% of participants felt the air quality in their city was very poor to poor on average, with only 20.8% stating they felt it was fair to very good. Furthermore, 15.6% of respondents indicated never having experienced shortness of breath whilst being outside recently, while 57% indicated they had. In terms of personal knowledge, overall 48.8% of respondents thought industrial sources was the largest source of pollution in their city (the correct answer), followed by traffic (31.7%), power plants (11%), other cities (6.1%), use of air conditioning (2.1%) and city development/construction work (.3%). As in all three cities governmental data indicates traffic is the largest source of air pollution, 31.7% of the current sample a correct understanding of pollutant sources in their city.

When asked what participants would do to fight against air pollution, .9% indicated not caring, 8.5% indicated remaining passive, the vast majority intended to take self-protective measures (76.1%), a small group would participate in active behaviours such as tree planting (9.3%) and 3.3. % intended on engaging with NGOs, protesting, etc. As such, the current sample seemed to have quite a negative impression of air quality, good understanding of the major sources and over 90% intended to act upon it.

5.3.2 Prediction of behavioural intentions.

To assess the linear relations between the models' predictor variables and behavioural intentions, a bivariate Pearson's correlation coefficient (*r*) was calculated. Prior to calculating *r*, the assumptions for bivariate correlation were assessed, and found to be reasonably supported. Apart from governmental trust and household composition, all variables were significantly correlated to self-protective intention at $p > .01$. All variables, apart from age and household composition, were significantly correlated to environmentally friendly intention at $p < .01$, see TABLE 6. A point-biserial correlation indicated a non-significant correlation between gender and dependent values, self-protective intention ($r_{pb} = -.01$, $p > .05$) and environmentally friendly intention ($r_{pb} = .06$, $p < .05$). Then, Spearman's rho indicated a non-significant correlation between education level and dependent variables self-protective intention (r_s = -.05, p > .05) and environmentally friendly intention (r_s = .07, p < .05).

TABLE E.

Pearson's Correlations Between Behavioural Intentions and Independent Variables

Variable	Self-protective intention	Environmentally friendly intention
Self-protective intention	-	.36**
Environmentally friendly intention	.36**	-
Self-efficacy	.57**	.32**
Outcome efficacy: positive outcomes	.35**	.27**
Outcome efficacy: perceived barriers	-.23**	-.13**
Risk perception: susceptibility	.26**	.21**
Risk perception: severity	.21**	.15**
Environmental risk perception	.23**	.23**
Use of governmental information	.32**	.17**
Use of media information	.23**	.13**
Use of peer information	.14**	.15**
Shortness of breath experience	.2**	.1**
Nose allergy experience	.21**	.1**
Perceived air quality	-.1*	.07
Governmental trust	-.01	.1**
Age	.12**	.04
Number children	.04	.03
Number adults	-.06	.03
Number elderly	-.04	-.02

Note. N = 699. *p < .05, **p < .01. Two-tailed.

From these findings, several interesting things stand out. For example, although both forms of outcome efficacy are related to behavioural intentions, thinking one's actions have positive outcomes had a stronger correlation than the barriers one perceives. This could also mean that for environmentally friendly behaviour, “doing good” is a stronger motivator of intention than the “perceived costs”. Additionally, almost all variables showed significant relations to the outcome variables, and in the expected directions. However, almost none of the socio-demographics showed significant correlation to either of the behavioural intentions, fitting into the pattern seen in table 1, p. 18. Furthermore, of the three information sources, governmental sources showed the highest correlation to both behavioural intentions. This could indicate that frequently receiving information from a trusted authority, such as the government, is a stronger motivator than receiving information from the media or peers.

5.3.3 Self-protective intention.

Base model

To test the hypothesis that the base model can account for a significant proportion of the variance in self-protective intention, a standard multiple regression analysis (MRA) was performed. Prior to interpreting the results of the MRA, several assumptions were evaluated. Several variables were slightly negatively skewed, with both negative and positive outliers. However, violations were not deemed extreme. Second, assumptions of normality, linearity and homoscedasticity of residuals were met. Mahalanobis distance exceeded the critical X^2 for $df = 6$ (at $\alpha = .001$) of 24, indicating multivariate outliers were of some concern. Upon inspection of standardized residuals, Cook’s distance, leverage scores and standardized DFbeta’s, nine participants were found with extreme scores. Upon inspection, five cases were deleted from further analysis. Although all five cases scored extremely low on both self-protective and environmentally friendly intentions, when asked “what will you do to fight against air pollution?”, cases indicated to perform either “self-protective behaviour (e.g. wearing a facemask)” or “active behaviour (e.g. tree planting)” (this question was not part of both intentional variable scales). This discrepancy indicated a distortion during participation, and cases were therefore deleted.

In combination, the six predictors accounted for a significant 35% of the variability in self-protective intention, $R^2 = .35$, adjusted $R^2 = .35$, $F(6, 679) = 61.1$, $p = .00$. Unstandardized (B) and standardized ($ß$) regression coefficients, t values and significance levels are reported in table 7. As can be seen in the table, the only significant predictor of self-protective intention is self-efficacy, with $\beta = .52$, $t(679) = 13$, $p < .01$. Interestingly, although the other five variables were not significant predictors, they were significantly correlated to self-protective intention. To further examine this discrepancy, a backward method MRA was performed. Now, in three steps perceived barriers, perceived positive outcome and environmental risk perception were removed from the model. The model still accounted for 35% of variability in self-protective intention, $R^2 = .35$, adjusted $R^2 = .35$, $F(3, 682) = 121.36$, $p = .00$. Now, in addition to the model constant, self-efficacy ($\beta = .54$, $t(682) = 16.63$, $p = 0.00$) and severity risk perception ($\beta = .08$, $t(682) = 2.21$, $p = .028$) significantly predicted self-protective intention. By Cohen's (1988) conventions, a combined effect of this magnitude can be considered large ($f^2 = .54$). As such, perceiving the risk of air pollution being severe does seem to have some predictive value in regards to protecting oneself within the current sample.

Table 7.

Summary of Multiple Regression Analysis for Base Model Predicting Self-protective Intention

	Coefficients			
Variables	*B*	*ß*	*t*	Sig.
Constant	.66		2.82	.00**
Self-efficacy	.55	.51	13	.00**
Outcome efficacy: positive outcomes	.03	.03	.84	.4
Outcome efficacy: perceived barriers	-.01	-.01	-.15	.88
Risk perception: susceptibility	.06	.06	1.39	.17
Risk perception: severity	.07	.07	1.81	.07
Environmental risk perception	.05	.04	1.19	.23

* $p < .05$, ** $p < .01$. Dependent variable: self-protective intention

Expanded model

Then, a three-step hierarchical MRA was employed, to test the predictive power of the full model, accounting for demographic variables. Before interpreting the results of the MRA, a number of assumptions were tested. Only perceived average city air quality was found too positively skewed, with *M* = 1.93 and *SD* = .8. Computing the natural logarithm did not improve normality to the extent where it was deemed acceptable, and the variable was therefore not included in the regression analysis. Assumptions of normality, linearity and homoscedasticity of residuals were met. Upon inspection of outliers and influential cases, six additional participants were found with extreme scores and multivariate outliers. However, deletion did not improve precision of the standard errors, and as such the cases were not deleted.

On step 1 of the hierarchal MRA, age accounted for a significant 1.8% of variance in self-protective intention, R^2 = .02, *F(*1, 680) = 12.52, *p* = .00. On step 2, environmental risk perception, perceived barriers, positive outcome, severity risk perception, self-efficacy and susceptibility risk perception were added to the regression equation, and accounted for an additional 33.7% of variance, ΔR^2 = .34, ΔF (6, 674) = 58.66, *p* = .00. On step 3, governmental trust, frequency of gaining air pollution information from the government, media and peers, recent experience with shortness of breath outside and recent experience with nose allergic symptoms whilst being outside were added to the regression equation, and accounted for an additional 2.4% of variance, ΔR^2 = .02, ΔF (6, 668) = 4.28, *p* = .00. The effect size is considered large (f^2 = .62). Unstandardized (*B*) and standardized (*ß*) regression coefficients, *t* values and significance levels for each predictor per step of the hierarchal MRA are reported in Table 8 As can be seen in the table, in the final stage, age (*β = .04, t*(681) = 2.1, *p* = 0.04), self-efficacy (*β = .5, t*(681) = 11,59, *p* = 0.00), governmental information (*β = .09, t*(681) = 3.64, *p* = 0.00), and shortness of breath experience (*β = .06, t*(681) = 2.13, *p* = 0.03) significantly predicted self-protective intention.

These findings partially support hypothesis 2A. Interestingly, having experienced shortness of breath while being outside showed some predictive power to protect oneself against air pollution, while experiencing nose allergies due to air pollution did not. As these experiences are quite similar, these outcomes could indicate that shortness of breath is a more impactful experience than experiencing an allergic reaction, such as a runny nose.

See table 8 on p. 46.

Table 8.

Summary of Multiple Regression Analysis for Expanded Model Predicting Self-protective Intention

	Coefficients			
Variables	*B*	*ß*	*t*	Sig.
Constant	.55		2.1	.03*
Age	.00	.06	2.06	.04*
Self-efficacy	.5	.47	11.49	.0**
Outcome efficacy: positive outcome	.05	.05	1.25	.21
Outcome efficacy: perceived barriers	-.02	-.02	-.59	.56
Risk perception: susceptibility	.04	.03	.84	.40
Risk perception: severity	.03	.03	.65	.51
Environmental risk perception	.06	.04	1.27	.20
Governmental trust	.01	.01	.39	.69
Use of governmental information	.09	.13	3.64	.0**
Use of media information	.02	.03	.81	.42
Use of peer information	-.04	-.05	-1.5	.13
Shortness of breath experience	.06	.08	2.1	.03*
Nose allergy experience	-.00	-.00	-.08	.94

* $p < .05$, ** $p < .01$. Dependent variable: self-protective intention.

Note. Summary of outcomes step 3 of MRA, see Appendix B for complete output.

5.3.4 Environmentally friendly intention.

Base model

To test the hypothesis that the base model can account for a significant proportion of the variance in environmentally friendly intention, a standard multiple regression analysis (MRA) was performed. Prior to interpreting the results of the MRA, several assumptions were evaluated. Several variables were slightly negatively skewed, with both negative and positive outliers. However, violations were not deemed extreme. Second, assumptions of normality, linearity and homoscedasticity of residuals were met. Upon inspecting for outliers and influential cases, ten participants were found with extreme scores. Upon inspection, four cases were deleted from further analysis, all of which had also been deleted in analyses of self-protective behaviour, for the same reason.

In combination, the six predictors accounted for a significant 14.1% of the variability in self-protective intention, $R^2 = .14$, adjusted $R^2 = .13$, $F(6, 680) = 18.57$, $p = .00$. Unstandardized (*B*) and standardized (*ß*) regression coefficients, *t* values and significance levels are reported in table 9. As can be seen in the table, self-efficacy ($\beta = .24$, $t(686) = 4.65$, $p < .00$), positive outcome expectancies ($\beta = .14$, $t(686) = 2.86$, $p = .00$) and environmental risk perception ($\beta = .11$, $t(686) = 1.99$, $p < .05$) significantly predicted intention to perform environmentally friendly behaviour.

See table 9 on p. 48.

Table 9.

Summary of Multiple Regression Analysis for Base Model PredictingEnvironmentally Friendly Intention

	Coefficients			
Variables	*B*	*ß*	*t*	Sig.
Constant	1.11		3.77	.0**
Self-efficacy	.25	.21	4.65	.0**
Outcome efficacy: positive outcomes	.14	.12	2.86	.0**
Outcome efficacy: perceived barriers	.01	.01	.30	.76
Risk perception: susceptibility	.1	.08	1.83	.07
Risk perception: severity	.03	.03	.56	.58
Environmental risk perception	.11	.09	1.99	.05*

* p < .05, **p < .01. Dependent variable: self-protective intention.

Expanded model.

Then, a two-step hierarchical MRA was employed, to test the predictive power of the full model. A step including demographic variables was not included, as none of the demographic variables significantly correlated to environmentally friendly intention. Before interpreting the results of the MRA, a number of assumptions were tested. Assumptions of normality, linearity and homoscedasticity of residuals were met. Upon testing outliers and influential cases, no additional cases were deleted.

On step 1 of the hierarchal MRA, the base model accounted for a significant 13.3% of variance in self-protective intention, $R^2 = .13$, $F(6, 676) = 18.46$, $p = .00$. On step 2, governmental trust, information source variables, shortness of breath experience and nose allergy experience were added to the regression equation, and accounted for an additional 2.7% of variance, $\Delta R^2 = .03$, $\Delta F\ (6, 670) = 3.58$, $p < .01$. The effect size is considered medium (f^2 = .2). Unstandardized (*B*) and standardized (*ß*) regression coefficients, *t* values and significance levels for each predictor per step of the hierarchal MRA are reported in Table 10. As can be seen in the table, in the final stage, self-efficacy (*ß = .21, t*(682) = 3.83 , *p* = 0.00), positive outcome expectancies (*ß* = .15 ., *t*(682) = 3.13, *p* < .01), environmental risk perception (*ß* = .12., *t*(682) = 2.2, *p* = .03), and governmental trust (*ß = .15, t*(682) = 3.83, *p* = .00) significantly predicted environmentally friendly intentions.

These findings partially support hypothesis 2B. Findings indicate that the prospect of negative health impacts does not predict actions aimed to reduce urban air pollution, yet perceiving the issue as an environmental risk does, as well as expecting positive outcomes of one's behaviour. This again underscored the idea that perceived benefits are a more important determinant of pro-environmental behaviour than perceived costs.

Table 10.

Summary of Two Step Multiple Regression for Complete Model Predicting Environmentally Friendly Intentions.

	Coefficients			
Variables	*B*	*ß*	*t*	Sig.
Constant	.53		1.62	.11
Self-efficacy	.21	.18	3.83	.0**
Outcome efficacy: positive outcome	.15	.13	3.13	.0**
Outcome efficacy: perceived barriers	.02	.02	.55	.59
Risk perception: susceptibility	.1	.08	1.78	.08
Risk perception: severity	.02	.02	.4	.69
Environmental risk perception	.12	.09	2.2	.03*
Governmental trust	.15	.14	3.83	.0**
Use of governmental information	.04	.05	1.3	.19
Use of media information	.02	.02	.44	.66
Use of peer information	.03	.04	.89	.37
Shortness of breath experience	.03	.04	.92	.36
Nose allergy experience	-.02	-.02	-.59	.55

* p < .05, **p < .01. Dependent variable: self-protective intention.

5.3.5 Difference between cities.

Personal experience.

To test whether respondents in a high-risk city differed in their air pollution experience, several ANOVA and MANOVA were conducted. For experience of nose allergies and shortness of breath due to air pollution, assumptions of normality and homogeneity of variance were not violated, and both *F* tests were not significant, with *F* (2, 690) = 1.19, *p* = .3 and *F* (2, 689) = .94, *p* = .39. Furthermore, reliance on different information sources (governmental, media and peers) for smog information did not significantly differ in the three cities. The assumption of normality was not met for perceived average air quality, yet the assumption for homogeneity of variances was. Given the robust nature of ANOVA, the test was still conducted. The one-way between groups ANOVA was statistically significant, indicating that perceived average air quality was indeed influenced by participants' places of residence, *F* (2, 291) = 34.39, *p* = .00. Post hoc analyses with Tukey's HSD (using $\propto$ of .05) revealed that residents of Taipei (*M* = 2.3, *SD* = .82) perceived the average air quality significantly better than those of Taichung (*M = 1.80*, *SD* = .74) and Kaohsiung (*M* = 1.76, *SD* = .72), although there was no significant difference between participants from Taichung and Kaohsiung. This is interesting, as the objective air quality is still worse in Kaohsiung than in Taichung, which could mean that either Kaohsiung residents underestimate the severity of air pollution, or that Taichung residents overestimate it.

Risk perception.

To assess whether respondents differed in their perceptions of risk, a MANOVA was executed, using all three risk perception variables. Assumptions for multicollinearity and multivariate outliers were checked and found to be of no issue. Additionally, the relationships between dependent variables were roughly linear. The Shapiro-Wilk test of univariate normality was significant for all three risk perception variables. This is generally not regarded as problematic, as MANOVA is considered robust with respect to univariate non-normality when group sizes exceed 30. However, boxplots indicated that departure from normality was too severe for environmental risk perception, which was therefore excluded. With two variables remaining, Box's test was non-significant (at α = .001), indicating that homogeneity of variance-covariance matrices could be assumed. The MANOVA was non-significant, *F* (4, 1388) = 2.1, *p* = .08, partial η^2 = .01. However, analysis of the dependent variables individually showed a significant effect for risk perception susceptibility at a Bonferroni adjusted alpha level of .025, F (2, 694) = 4.07, p = .02, partial η^2 = .01, which indicates a small effect size. Specifically, respondents in Taichung (M = 4.05) reported significantly higher susceptibility to air pollution risk than did respondents in Kaohsiung (M = 3.89). These findings supported findings in 4.2.4, which discussed Taichung residents being more concerned about air pollution than Kaohsiung residents.

Governmental trust.

Differences in terms of governmental trust were examined for the three different cities, using a between-groups ANOVA. Although Shapiro-Wilk test was significant, indicating non-normality, this was not deemed problematic, as boxplots did not indicate extreme skewness. Furthermore, Levene's test was non-significant, thus the assumption of homogeneity of variance was not violated. The ANOVA was significant, indicating governmental trust was influenced by respondents' city of residence, F (2,692) = 3.72, p = .025, partial η^2 = .01, indicating a small effect size. Post hoc analyses with Tukey's HSD indicated that participants in Taipei (M = 2.46) reported significantly higher trust in government policies than participants in Kaohsiung (M = 2.27). This could indicate that, as stated in 4.2.4, residents of Kaohsiung indeed perceive receiving les governmental resources to abate air pollution, than in Taipei.

Behavioural intentions.

Finally, two ANOVA were executed for both self-protective and environmentally friendly behaviours. Although normality could not be assumed for self-protective intention, homogeneity of variance assumptions was not violated, yet the ANOVA test was not significant, F (2,696) = 1.73, p = .178, with a small effect size of .00. Interestingly, a significant effect was found for environmentally friendly intention, F (2, 696) = 6.85, p < .01, partial η^2 = .02. To further analyse this, a MANOVA was conducted using all four environmentally friendly behaviour intentions (reducing personal car usage, increase usage of public transport, increase usage of energy-saving appliances and choosing green transport), with a significant effect found, F (8, 914) = 2, p = .04, partial η^2 = .02. A non-significant Box's M was non-significant, indicating homogeneity of variance-covariance matrices could be assumed, and multicollinearity was not of concern. Furthermore, relationships between dependent variables were roughly linear. Tukey's HSD analysis revealed that both respondents from Taipei and Taichung indicated intentions to choose public transport and green transport more often to combat air pollution, than residents of Kaohsiung. Group means for each dependent variable are presented in Table 11. This is interesting, as Kaohsiung has a more elaborate public transport system, with for example a metro system, than Taichung. Thus, despite more structural barriers, residents of Taichung seem more motivated to take measures that will combat air pollution.

Table 11.

Descriptive statistics for residents of Taipei, Taichung and Kaohsiung on each dependent variable.

	Mean	Std. Deviation
Car usage		
Taipei	3.5	.09
Taichung	3.42	.09
Kaohsiung	3.25	.06
Public Transport		
Taipei	3.8	.09
Taichung	3.74	.08
Kaohsiung	3.48	.06
Energy Appliances		
Taipei	3.97	.08
Taichung	3.91	.07
Kaohsiung	3.83	.05
Green Transport		
Taipei	3.86	.1
Taichung	3.75	.09
Kaohsiung	3.46	.07

Note. Means on a 1-5 scale.

6. Discussion

6.1 Limitations

The current study set out to untangle which socio-behavioural factors influence self-protective behaviour against city smog among a Taiwanese urban sample, as well as placing them in the context of social, economic and political developments of Taiwan. However, several limitations of the study are to be taken into account when interpreting results.

Firstly, the model tested in the current work proposed personal knowledge as a predictor of behavioural intentions. However, within the questionnaire this was only measured using one item, asking about the largest source of air pollutions in one's city. However, this measure was deemed too limited to accurately assess respondents' personal knowledge, and therefore not included in statistical analyses. As such, personal knowledge, as part of "cues to action", has not been tested for its relation to behavioural intentions.

During data gathering, in Taichung paper questionnaires were spread among employees (and families) of a research institute, whereas in Taipei and Kaohsiung sampling was done in public spaces. This variability in data gathering may hamper overall reliability of the results, as well as generalizability to an urban Taichung audience. Analysis of variance did not show a significant difference between demographic variables between the three cities however. For example, the Taipei and Taichung samples had a roughly similar distribution of education level, only Kaohsiung had a slightly lower, yet non-significant, average level of education. As such, the current findings do not indicate the sampling method was an issue, mixing the paper and online samples may have diversified the overall sample, improving external validity to some extent.

However, the overall sample did deviate from the Taiwanese population on several aspects, being more highly educated, younger and female. In line with previous research, this could contribute to the high levels of risk perception, and willingness to take action. Therefore, it is difficult to draw conclusions whether different demographic groups, especially lower educated and low-income groups, as well as aboriginal Taiwanese, will show similar patterns. Especially in light of their increased vulnerability to the effects of urban air pollutions, future studies should focus on these demographic groups, in order to assess whether the behavioural model holds in different circumstances. Additionally, this may also increase insight into the differences in public awareness, discussed by participants of the several air pollution NGO's.

Within the questionnaire, there was a small bias in the questions toward self-protective behaviour, meaning more questions addressed self-protective behaviour than pro-environmental behaviour. This may (in part) explain why the overall predictive power and correlations within the environmentally friendly model were lower than for the self-protective model. Thus, within the current study, the behavioural model was somewhat more fitting for self-protective behaviour, than for environmentally friendly behaviours.

6.2 Air Pollution in Taiwan: Key Findings

In terms of health risks, the findings suggest that despite a decreasing trend of air pollutant concentrations, the health risk urban air pollution poses is still eminent in all three of Taiwan's major cities. Most previous studies focussed on the health impacts of a specific disease in one locale. However, the current findings suggest air pollution severity, and thus its health impacts, are not equally divided across Taiwan, with Taipei being least affected, followed by Taichung and Kaohsiung. This North-South divide becomes apparent from both national statistics, as well as from the stories shared by respondents. Future studies may attempt to compare health impacts and their severity across the country. This is detrimental, as currently resources to decrease health impacts do not seem to be allocated in an equitable manner.

Additionally, previous studies indicated a relation between neighbourhood SES and pollution severity in north America, New Zealand, Hong Kong and Ghana (Hajat, Hsia & O'Neill, 2015). However, in light of the current findings, this pattern seems to be more complicated in Taiwan. The finding of a North-South divide, in terms of socio-economic development and air pollution severity, underpins the importance of local context within the current empirical field. Therefore, these findings can have implications for future studies. However, these findings are based on a qualitative assessment of multiple data sources. More rigorous research is recommended, in order to make claims with precise theoretical and policy implications. To do so, studies should simultaneously measure both (neighbourhood) SES and air pollution exposure in order to assess their relation. The current findings further suggest that Taiwanese of aboriginal descent are disproportionately affected air pollution. Thus, in addition to SES, ethnicity seems especially relevant to take into account.

Another key finding is that despite increased efforts by the Taiwanese central government to abate air pollution over the past decades, public concern has grown rapidly since 2011. Additionally, the public has found more intricate ways to voice concerns. As the current findings suggest, this may in part be due to the emergence of fear appeals, both in anecdotal form and in terms of spread of scientific information. An additional factor explaining the growing public reactance is a sense of unfair treatment, voiced by several respondents. More specifically, there seems to be a rhetoric among citizens engaged in the NGO movement that the government does not take adequate measures to protect citizens from air pollution, thus legitimizing the large protests and other public action. Furthermore, although Kaohsiung respondents perceived average air quality to be low, the current findings suggest they may underestimate the risk compared to citizens in Taichung and Taipei.

6.3 Behavioural Intentions: Key findings

In terms of behavioural intentions, several key findings can be mentioned. Firstly, Taiwanese urban residents seem more highly concerned about air pollution than found in other studies. This could indicate good momentum for both government and NGOs to take large-scale action, with the support of citizens. Even so, the positive causal relation between trust in governmental policy and environmentally friendly intentions could indicate that Taiwanese urban citizens do not just take action when they think the government is not, but are willing to act if they trust the government is also taking effective measures. However, governmental trust was originally not ascribed to the proposed model (see Figure 5, p. 14), but was added to the questionnaire by Taiwanese researchers given its contemporary relevance in Taiwan's society. The findings of the current sample could suggest that one's willingness abate urban air pollution, is influenced by governmental trust. Indeed, earlier studies have found similar patterns, indicating that intensity of institutional trust predicts a range of pro-environmental behaviours (Wynveen & Sutton, 2015; Kollmuss & Agyeman, 2002). The current findings further indicate the relation between governmental trust and behavioural intention is non-relevant for behaviour purely aimed at protecting the self. As such, the role of governmental trust might only be activated for behaviours benefit the public domain. Interestingly though, Taiwanese urban respondents did seem to place high confidence in information from the government, as this was an important predictor of self-protective intention.

In spite of the high levels of risk perception and behavioural intentions in the overall sample, there seemed to be some differences between respondents of the three different cities. Interestingly, despite having the worst air quality objectively, Kaohsiung respondents did not perceive their risk higher than respondents in Taichung or Taipei. In fact, respondents in Taichung perceived the health risks of air pollution in their city to be higher than those in Kaohsiung. This could mean that, as mentioned by several respondents, the public of Kaohsiung is indeed not aware or worried about air pollution. As several respondents also mentioned, the air pollution NGO's are most active in Taichung, in terms of public interventions. As such, the findings could mean that their efforts have been effective in creating more public awareness and concern in Taichung.

Based on findings of the model, hypotheses 1 and 2 were partially supported, and have several theoretical and practical implications. Both hypotheses predicted the complete model to be predictive of self-protective and environmentally friendly behavioural intentions. However, in both cases, the findings suggested parts of the model to hold. Firstly, demographic variables do not seem to have a clear-cut relation to self-protective intentions. Findings of previous studies indicated age does not have a causal relation to self-protection (Weit et al., 2017; Cheng et al., 2017), yet the current findings found the opposite. Furthermore, the reverse trend was found for gender and education level, which did not show significant relations to the dependent variables. This may indicate that the effects of demographics variables on self-protective intentions are dependent on the socio-spatial context. It could for example mean that health concerns such as air pollution receive a higher sense of urgency as one gets older in Taiwan, yet not in another country. In China for example, family and kinship are at the centre of one's social relations, where grandparents often play an integral part as heads of the family, both through the common practice of co-residence and providing care (Chen, Liu & Mair, 2011; Jingxiong et al., 2007; Logan, Bian & Bian, 1998; Tian & Lin, 2016). This could mean that this caretaking role for the extended family makes elderly family members more susceptible to fear appeals to family health, especially if grandchildren are more at risk from air pollution.

The high correlations between demographic variables and other predictors in the model hints at a more indirect and nuanced pathway between demographics and self-protective intentions, perhaps a moderating effect. If future studies can untangle these relations, this might enable risk communicators to better attune their message to different socio-demographic niches.

Secondly, in line with previous studies (Zhou et al., 2016), current findings suggest that feeling efficacious to take certain measures, is a strong motivator for wanting to take action. The findings of the current sample indicate that stimulating self-efficacy among urban residents of Taiwan can effectively motivate them to protect themselves against air pollution, as well as take actions to diminish air pollution altogether. As the sample indicated having high self-efficacy, using verbal persuasion in public spaces could for example activate self-efficacious feelings. However, during the focus group discussion the respondents indicated having past experience with small tasks such as wearing a facemask (an important characteristic of self-efficacy), yet lacking confidence and knowledge about more impactful behaviours. Although these are not generalizable findings, it may be reason to further analyse which behaviours

Taiwanese urban citizens feel efficacious about, enabling risk communicators to design interventions more concisely.

Additionally, the role of outcome-efficacy, the belief a behaviour will lead to a certain outcome, in predicting self-protection remains inconclusive, as a causal relation was found with environmentally friendly behaviour, yet not with self-protective behaviour. Within the literature, the role of outcome efficacy in combination with self-efficacy has been debated for some time (Williams, 2010), with some studies suggesting outcome-efficacy may influence perceptions of self-efficacy (Maddux, Sherer & Rogers, 1982). Perhaps the important role of self-efficacy found in the current sample could take whatever predictive power outcome efficacy had. Therefore, future studies may attempt to untangle the interrelatedness between outcome and self-efficacy, to enhance parsimony and accuracy of the model.

Lastly, the role of cues to action in explaining smog-related behavioural intentions seems promising in light of the current results. Earlier studies indicated personal health experiences increase concern about air pollution (Skov et al., 1991; Xi et al., 2017). Yet current findings suggest personal experience may also directly influence a person's intention to protect themselves against air pollution. Furthermore, Taiwanese urban residents seem to take governmental information more seriously than media or peer information, as this was the only information source showing causal influence on self-protective intention. Future studies may investigate whether the dire warning by the Taiwanese government could mediate the role of risk perception, as found in the work by Cheng et al. (2017), or the role of other variables within the proposed model.

7. Conclusion

In Taiwan, air pollution is indeed an important health hazard, in need of addressing. The current study aimed to look at the role of self-protective behaviour in abating the detrimental health impacts of air pollution on urban citizens. Based on the findings, several conclusions can be made.

The role of different locales seems relevant in the case of Taiwan. This mainly became apparent through the North-South divide, both in terms of socio-economic indicators and air pollution severity. Based on these findings, more resources should go to fighting air pollution and promoting health behaviour in Kaohsiung, as SES seemed to be generally lower, and participants less concerned about air pollution. Additionally, further use of participatory modelling techniques, in which the government calls upon lay knowledge, may give more agency to Taiwan's concerned citizens, while giving more legitimacy to EPA policies.

The outcomes of the behavioural model showed several key findings. Although not all outcomes were conclusive, self-efficacy, perceived susceptibility, personal experience and receiving governmental information were found causally predictive of self-protective intentions. Self-efficacy, perceived positive outcomes, environmental risk perception and governmental trust were found causally predictive of intentions to perform environmentally friendly actions to decrease urban air pollution, among participants in three Taiwanese cities. Although the tested model was new, and therefore more studies are needed to fine-tune it, these findings have several theoretical and practical implications.

From a theoretical perspective, the current findings partially confirm findings of earlier studies on self-protection against air pollution within Asia. However, it also advances knowledge of psychological constructs within self-protective behaviour and health behaviour with new findings. Earlier studies used single variables to represent outcome efficacy and risk perception. A study by Cheng et al. (2017) found risk perception was not a significant predictor of environmentally friendly intentions. The current study suggests a more nuanced picture. Indeed, one's perceived own health risks are not strong motivators for wanting to perform actions to abate urban air pollution. Yet perceiving the risk in terms of its environmental impacts, may spur action to take protective actions, such as taking public transport and using energy-saving appliances.

The current findings may give some insights to policy makers and risk communication professionals, when trying to influence self-protective behaviours against air pollution, within Taiwanese cities. For example, interventions aimed at increasing the self-efficacy of certain behaviours will more likely lead to self-protective intentions than interventions that increase knowledge on the positive outcome of a specific behaviour. Such interventions could include visual cues in public spaces, such as leaflets or posters, that give verbal coercion through slogans or visualizing which steps to take to effectively protect oneself. Additionally, different interventions may be desirable for different age groups.

The current study aimed to combine the merits of several health behavioural models to produce a more comprehensive and parsimonious model of self-protective behaviour against air pollution, and test it within the context of Taiwan. Based on the current findings, the proposed model cannot be completely assumed. However, they do confirm the important role of feeling self-efficacious and aware of the risk in intending to protects oneself against air pollution, as well as the role of demographic factors and cues to action, such as informational source. Additionally, the complexity of the findings suggest the models used to date have been too simplistic, calling for further investigation into the interrelations of several variables in predicting self-protective and environmentally friendly intentions. Advancing this knowledge will help understanding through which pathways individuals take action protect themselves against the health and environmental impacts of urban air pollution, within different geographical and societal contexts.

8. Literature

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9. Appendix

Appendix A: Questionnaire (English and Mandarin)

台灣地區民眾對空氣污染風險知覺與自我保護行為調查研究問卷

親愛的先生/女士：您好。

非常感謝您花時間填寫這份問卷，我們想要了解您對所在都市空氣污染的經驗，此份問卷是國立臺灣師範大學和荷蘭Utrecht大學碩士論文研究的一部分，藉由填寫這份問卷，您將有助於我們持續對抗空氣污染。下列問題中，所謂的「高污染日」係指空氣污染嚴重的日子，所謂的「自我保護行為」係指諸如戴口罩、待在室內、或使用空氣清淨機等行為，來減少空氣污染的危害。您所填寫的答案都會嚴格保密，並僅供做學術研究使用，當您填寫到一半時有所顧慮的話，可以隨時停止回答，我們將不會對這份問卷留下任何紀錄。

敬祝　闔家平安，萬事如意。

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2018.3.26

行為意向 Behavioural Intention

◎針對下列問題，請選擇最適合代表您意見的答案，請打勾。

Please rate to which extent you agree with the following statements.

自我保護 Self-protective					
題項 options	完全不同意 Completely disagree	不同意 disagree	普通	同意 agree	完全同意 completely agree
在我所在的都市，當我知道高污染空氣預報，我會戴上口罩。 I intend to wear a facemask, when I hear of a high pollution event in my city.					
無論空氣品質如何，我都打算每天戴口罩。					

I intend to wear a facemask daily, regardless of the air quality broadcast.					
在我所在的都市，當我知道高污染空氣預報，我會減少在戶外的時間。 I will reduce my time spent outdoors the next time I hear of a high pollution event in my city.					
我在室內會使用空氣清淨機來保護自己免除都市空氣污染。 I will use an air filter to protect myself from urban air pollution.					
我會想搬到空氣品質較佳的地區居住或工作。 I intend to move to work or live in a city that has cleaner air.					

環境友善行為 Environmentally friendly					
題項 options	完全 不同意 Completely disagree	不同意 disagree	**普通**	同意 agree	完全 同意 completely agree
我將減少使用汽、機車以減少都市空氣污染。 I will reduce personal car use to cope with Air pollution.					
我將增加使用大眾運輸工具以減少都市空氣污染。 I will increase my use of public transport to cope with air pollution.					
我將節約能源以減少都市空氣污染。 I will use energy-saving appliances to cope with air pollution.					
我將使用綠色運具以減少都市空氣污染，如：腳踏車、電動機車等。 I intend to choose green transport to cope with air pollution (e.g. bike, electric motorcycle).					

二、風險知覺 Risk Perception

◎針對下列問題，請選擇最適合代表您意見的答案，請打勾。

Please rate to which extent you agree with the following statements.

感受性 Susceptibility					
題項 options	完全不同意 Completely disagree	不同意 disagree	**普通**	同意 agree	完全同意 completely agree
都市空氣污染對我的身體健康有負面影響。 Air pollution has adverse effects on my physical health.					
都市空氣污染對我的心理健康有負面影響。 Air pollution has adverse effects on my mental health.					
都市空氣污染對我的工作效率有負面影響。 Air pollution has adverse effects on my work efficiency.					
都市空氣污染對自然環境有負面影響。 Air pollution has adverse effects on our natural environment.					
空氣污染物會透過食物鏈污染我們所吃的食物。 Air pollutants would contaminate our food through food chain.					
都市空氣污染會影響氣候變遷。 Air pollution contributes to climate change.					
空氣污染不會帶給我任何風險。 Air pollution does not pose any risk for me.					
空氣品質不好時若待在戶外太久，我可能會有罹患呼吸道疾病的風險。 If I have to stay outside for a long time during smog days, I will risk getting a respiratory disease..					

嚴重性 Severity					
題項 options	完全不同意 Completely disagree	不同意 disagree	**普通**	同意 agree	完全同意 completely agree
我擔心空氣污染會對我的財產造成重大損害。 I worry about major damage to possessions from air pollution.					

我擔心空氣污染會對我家小孩發展造成重大傷害。 I worry about major damage to children's development because of air pollution.					
我擔心空氣污染會對我或家庭生活造成重大傷害。 I worry about major damage to personal or family life due to air pollution.					
空氣污染已對我的個人健康造成嚴重傷害。 Air pollution has had severe impacts on my personal health.					

三、 自我效能 Self-efficacy

◎針對下列問題，請選擇最適合代表您意見的答案，請打勾。

Please rate to which extent you agree with the following statements.

題項 options	完全 不同意 Completely disagree	不同意 disagree	**普通**	同意 agree	完全 同意 completely agree
我知道如何有效保護自己免除空氣污染危害的方法。 I know which measures to take to protect myself against Air pollution.					
當空氣品質不佳時，縱使戴口罩不舒服，我確信我會為了保護健康立即戴上口罩。 I am confident that I can start wearing a facemask immediately when I have to go outside for a long while (min 1h) on smog days, even if I feel uncomfortable with it at the very beginning. (action)					
即使無法看到立即的好處，空氣品質不佳時，在戶外我會持續戴著口罩。 I am confident that I can continue to wear a facemask when I have to stay outside for a long while on smog days, even if I cannot see any immediate benefit of it.					
為了對抗空氣污染而採取保護措施對我而言很費事。 Taking measures to protect myself against air pollution is too strenuous for me.					

4、 成果效能 Outcome efficacy

◎針對下列問題，請選擇最適合代表您意見的答案，請打勾。

Please rate to which extent you agree with the following statements.

正面成效 Positive outcome					
題項 options	完全 不同意 Completely disagree	不同意 disagree	**普通**	同意 agree	完全 同意 completely agree
當在空氣品質不佳的戶外活動時，戴口罩將會保護我的健康。 If I wear a facemask when I have to stay outside for a long while on a smog day, this will protect my health.					
保護自己對抗空氣污染將幫助我保持健康。 Protecting myself against smog will help me to stay healthy.					
空氣不好時減少戶外活動會使我獲得很多正面效益。 I have a lot to gain by reducing my time spent outdoors on high pollution days.					

阻礙認知 Perceived barrier					
題項 options	完全 不同意 Completely disagree	不同意 disagree	**普通**	同意 agree	完全 同意 completely agree
縱使空氣污染嚴重，在公共場所戴口罩會使我感到尷尬。 I feel embarrassed to wear a facemask in public, even when a smog event is severe.					
採取自我防護措施是浪費時間。 Self-protective measures are time-consuming.					
採取自我防護措施對我而言不方便。 Self-protective measures are inconvenient for me.					
養成對抗空氣污染的新習慣對我而言是困難的。 Taking self-protective measures against air pollution would require starting a new habit, which I find difficult.					

5、 行動誘因Cues to action

◎針對下列問題，請選擇最適合代表您意見的答案，請打勾。

Please rate to which extent you agree with the following statements.

資訊來源 Information sources
我主動查詢政府提供的空氣品質資訊的頻率（如：網站、APP）： How often do you rely on official government sources for air quality information? (e.g. website, APP, etc)

☐完全沒有Never ☐很少Hardly Ever ☐有時Sometimes ☐經常Usually ☐總是Almost Always
我透過媒體獲取空氣品質資訊的頻率（如：電視、報紙）： How often do you rely on media sources (e.g. news, social media, etc) for air quality information? ☐完全沒有Never ☐很少Hardly Ever ☐有時Sometimes ☐經常Usually ☐總是Almost Always
我從家人或朋友獲得空氣品質資訊的頻率： How often do you rely on friends and family for air quality information? ☐完全沒有Never ☐很少Hardly Ever ☐有時Sometimes ☐經常Usually ☐總是Almost Always

個人知識與經驗 Personal Knowledge and experience
平均來說，我覺得我所居住城市之空氣品質： The air quality in my city is on average ☐不知道Do Not Know ☐非常好Very Good ☐好Good ☐普通Fair ☐差Poor ☐非常差Very Poor
我所居住城市最大的空氣污染來源是： In my city, the largest source of air pollution is ☐交通Traffic ☐工廠Industrial Sources/ Manufacturing ☐營建工程Construction, City Development ☐使用空調Use of Air Conditioners ☐發電廠Power Plants ☐其它地區或國家移入Pollution From Other Cities and Countries
我有在戶外因空氣污染而感到呼吸困難的經驗： I have experienced shortness of breath while being outside recently ☐完全不同意Completely disagree ☐不同意disagree ☐普通 ☐同意agree ☐完全同意completely agree
我有因空氣污染而鼻子過敏的情形： I have nose allergic reactions due to air pollution ☐完全不同意Completely disagree ☐不同意disagree ☐普通 ☐同意agree ☐完全同意completely agree
我的家人有因空氣污染而鼻子過敏的情形： My family members have allergic reactions (e.g. nose allergies) due to air pollution ☐完全不同意Completely disagree ☐不同意disagree ☐普通 ☐同意agree ☐完全同意completely agree

六、政府政策與公民參與Government policy and citizen participation

◎針對下列問題，請選擇最適合代表您意見的答案，請打勾。

Please rate to which extent you agree with the following statements.

政府政策與公民參與Government policy and citizen participation
面對空氣污染，您會採取什麼的因應行為？ What will you do to fight against air pollution? ☐不關心、不在乎 I don’t care ☐消極行為（如：認為自我保護措施無效） passive behavior (e.g. It doesn’t work to do anything) ☐採取自我保護行為 （如：戴口罩、待在室內、或使用空氣清淨機等） self-protect behavior (e.g. wearing a facemask)

□積極參與維護空氣品質行動（如：自己監測空氣品質、植樹綠化等） active behavior (e.g. tree planting) □積極參與民間社團與政治活動（如：參加民間社團活動、街頭遊行等） engaging in NGOs, protests, etc.
您對政府空氣污染防治政策的信任度： Do you have confidence in government policy to combat air pollution? □極高Very High □高High □普通Ordinary □低Low □極低Very Low
您對所在地市政府所推動的空氣污染防治作為的看法？ What do you think of the air pollution prevention promoted by your local government? □非常積極Very Active □積極Active □普通Ordinary □不積極Passive □非常不積極Very Passive
您認為所在地市政府所推動的空氣污染防治作為是否有成效？ Do you think the air pollution prevention promoted by your local government is effective? □非常有效Very Effective □有效Effective □普通Ordinary □無效Invalid □不知道I Don't Know
您知道民眾參與式監測計畫「空氣盒子」嗎？ Have you ever heard the public participatory monitoring plan "Air Box"? □沒聽過No □聽過Yes □非常瞭解I know it very well □有時會參與監測上傳資料I sometimes participate in the plan □經常I usually participate in the plan
您贊成放「空污假」嗎？（空污假:當空氣品質達到嚴重惡化時，政府將宣布**停課**、停班。） Do you agree with having a day off on highly polluted days? □空氣污染不會帶給我任何風險Completely Disagree □不贊成Disagree □沒意見No Opinion □贊成Agree □非常贊成Completely agree
您認為您所在城市最大的問題是什麼（如：犯罪、貧困、污染）？ In your opinion, what is the biggest issue in your city (e.g. crime, poverty, pollution) ? 回答answer：____

七、個人資料部分Demographics

- 年齡age：________________。
- 性別gender：________________。
- 教育程度education：________________；專科、大學、研究所之主修科系major：________________。
- 居住地city of residence：________________市City；________________區District。
- 家庭總月收入(新台幣/元) household income per month (NTD)：

□37,500以下　□37,501~60,000　□60,001~85,000　□125,001以上

□85,001~125,00[1]

- 職業別occupation：

 □1.農林漁牧agriculture, forestry, fishery and animal husbandry □2.製造業manufacturing

 □3.商/服務業business/service □4.自由業self-employed □5.軍公教人員government official

 □6.老闆（小生意、企業、公司負責人）business owner □7.待業中still looking for offers

 □8.家管homemaker □9.學生student

 □10.其他others（具體答案be more specific：________________）

- 家庭人口結構family structure：

 幼年人口(0~14歲) children______人；

 壯年人口(15~64歲) adults ______人；

 老年人口(65歲以上) the elderly______人。

- 家中擁有空氣清淨機的數量：______________台。How many air filters are there in your house?
- 平均每週購買口罩的次數：__________次/週；How often do you buy facemasks in a week?

 平均每次購買口罩的數量：__________個。How many facemasks do you usually buy at a time?

~ 問卷結束，感謝您的作答 ~

END

[1] Note: the 85,001 - 125,000 option was missing in the actual questionnaire, and was added to the current version for future reference.

Appendix B: Expanded Output Tables

SPSS Output Correlation Matrix.

Correlations

		SelfProtectiveIntention	EnvironmentallyFriendlyIntention	SelfEfficacy	OUPositiveOutcome	OUPerceivedBarriers	RP_susceptibility	RP_severity	EnvRiskPerception	Info_Gov	Info_Media	Info_Family	ShortnessBreathOutside	NoseAllergy_Me	GovernmentalTrust	Age	Children	Adults	Elderly
SelfProtectiveIntention	Pearson Correlation	1	,359**	,570**	,349**	-,228**	,262**	,213**	,230**	,316**	,231**	,139**	,197**	,209**	-,006	,118**	,044	-,059	-,040
	Sig. (2-tailed)		,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,866	,002	,251	,122	,289
	N	699	699	696	694	694	697	697	697	691	693	693	690	691	695	696	697	692	697
EnvironmentallyFriendlyIntention	Pearson Correlation	,359**	1	,322**	,272**	-,129**	,216**	,152**	,231**	,166**	,132**	,145**	,101**	,099**	,103**	,044	,030	,028	-,018
	Sig. (2-tailed)	,000		,000	,000	,001	,000	,000	,000	,000	,000	,000	,008	,009	,006	,243	,426	,468	,627
	N	699	699	696	694	694	697	697	697	691	693	693	690	691	695	696	697	692	697
SelfEfficacy	Pearson Correlation	,570**	,322**	1	,550**	-,419**	,222**	,191**	,194**	,300**	,236**	,233**	,136**	,237**	,003	,072	,042	,013	-,014
	Sig. (2-tailed)	,000	,000		,000	,000	,000	,000	,000	,000	,000	,000	,000	,000	,931	,057	,267	,726	,721
	N	696	696	696	691	691	696	696	696	688	690	690	687	688	692	693	694	689	694
OUPositiveOutcome	Pearson Correlation	,349**	,272**	,550**	1	-,246**	,196**	,210**	,232**	,117**	,122**	,169**	,095*	,199**	-,042	,089*	,036	,007	-,014
	Sig. (2-tailed)	,000	,000	,000		,000	,000	,000	,000	,002	,001	,000	,012	,000	,274	,019	,345	,854	,717
	N	694	694	691	694	694	692	692	692	691	693	693	690	691	690	691	692	687	692
OUPerceivedBarriers	Pearson Correlation	-,228**	-,129**	-,419**	-,246**	1	-,032	,061	-,134**	-,068	-,148**	-,103**	,085*	,001	-,087*	,044	-,009	-,069	,014
	Sig. (2-tailed)	,000	,001	,000	,000		,405	,108	,000	,073	,000	,007	,026	,983	,023	,252	,823	,070	,709
	N	694	694	691	694	694	692	692	692	691	693	693	690	691	690	691	692	687	692
RP_susceptibility	Pearson Correlation	,262**	,216**	,222**	,196**	-,032	1	,551**	,478**	,206**	,125**	,088*	,266**	,210**	-,107**	,128**	,046	-,012	,001
	Sig. (2-tailed)	,000	,000	,000	,000	,405		,000	,000	,000	,001	,020	,000	,000	,005	,001	,229	,747	,987
	N	697	697	696	692	692	697	697	697	689	691	691	688	689	693	694	695	690	695
RP_severity	Pearson Correlation	,213**	,152**	,191**	,210**	,061	,551**	1	,382**	,249**	,195**	,172**	,377**	,302**	-,164**	,129**	,092*	-,056	,021
	Sig. (2-tailed)	,000	,000	,000	,000	,108	,000		,000	,000	,000	,000	,000	,000	,000	,001	,016	,141	,575
	N	697	697	696	692	692	697	697	697	689	691	691	688	689	693	694	695	690	695
EnvRiskPerception	Pearson Correlation	,230**	,231**	,194**	,232**	-,134**	,478**	,382**	1	,148**	,171**	,146**	,159**	,185**	-,150**	,021	,047	,083*	,069
	Sig. (2-tailed)	,000	,000	,000	,000	,000	,000	,000		,000	,000	,000	,000	,000	,000	,589	,217	,029	,069
	N	697	697	696	692	692	697	697	697	689	691	691	688	689	693	694	695	690	695
Info_Gov	Pearson Correlation	,316**	,166**	,300**	,117**	-,068	,206**	,249**	,148**	1	,466**	,309**	,219**	,196**	,003	,076*	,072	-,089*	,007
	Sig. (2-tailed)	,000	,000	,000	,002	,073	,000	,000	,000		,000	,000	,000	,000	,942	,045	,059	,020	,849
	N	691	691	688	691	691	689	689	689	691	691	691	688	689	688	689	689	684	689
Info_Media	Pearson Correlation	,231**	,132**	,236**	,122**	-,148**	,125**	,195**	,171**	,466**	1	,410**	,203**	,211**	-,034	,028	,032	-,007	,066
	Sig. (2-tailed)	,000	,000	,000	,001	,000	,001	,000	,000	,000		,000	,000	,000	,371	,464	,401	,863	,081
	N	693	693	690	693	693	691	691	691	691	693	693	690	691	690	691	691	686	691
Info_Family	Pearson Correlation	,139**	,145**	,233**	,169**	-,103**	,088*	,172**	,146**	,309**	,410**	1	,150**	,148**	-,033	-,017	,069	-,025	,008
	Sig. (2-tailed)	,000	,000	,000	,000	,007	,020	,000	,000	,000	,000		,000	,000	,388	,652	,069	,509	,830
	N	693	693	690	693	693	691	691	691	691	693	693	690	691	690	691	691	686	691
ShortnessBreathOutside	Pearson Correlation	,197**	,101**	,136**	,095*	,085*	,266**	,377**	,159**	,219**	,203**	,150**	1	,423**	-,125**	,033	,033	-,048	,011
	Sig. (2-tailed)	,000	,008	,000	,012	,026	,000	,000	,000	,000	,000	,000		,000	,001	,382	,390	,211	,765
	N	690	690	687	690	690	688	688	688	688	690	690	690	690	687	688	688	683	688
NoseAllergy_Me	Pearson Correlation	,209**	,099**	,237**	,199**	,001	,210**	,302**	,185**	,196**	,211**	,148**	,423**	1	-,140**	,027	,053	,001	,002
	Sig. (2-tailed)	,000	,009	,000	,000	,983	,000	,000	,000	,000	,000	,000	,000		,000	,486	,163	,986	,951
	N	691	691	688	691	691	689	689	689	689	691	691	690	691	688	689	689	684	689
GovernmentalTrust	Pearson Correlation	-,006	,103**	,003	-,042	-,087*	-,107**	-,164**	-,150**	,003	-,034	-,033	-,125**	-,140**	1	-,050	-,070	,024	-,019
	Sig. (2-tailed)	,866	,006	,931	,274	,023	,005	,000	,000	,942	,371	,388	,001	,000		,188	,065	,534	,622
	N	695	695	692	690	690	693	693	693	688	690	690	687	688	695	693	693	688	693
Age	Pearson Correlation	,118**	,044	,072	,089*	,044	,128**	,129**	,021	,076*	,028	-,017	,033	,027	-,050	1	,108**	-,275**	,126**
	Sig. (2-tailed)	,002	,243	,057	,019	,252	,001	,001	,589	,045	,464	,652	,382	,486	,188		,004	,000	,001
	N	696	696	693	691	691	694	694	694	689	691	691	688	689	693	696	694	689	694
Children	Pearson Correlation	,044	,030	,042	,036	-,009	,046	,092*	,047	,072	,032	,069	,033	,053	-,070	,108**	1	-,189**	,110**
	Sig. (2-tailed)	,251	,426	,267	,345	,823	,229	,016	,217	,059	,401	,069	,390	,163	,065	,004		,000	,004
	N	697	697	694	692	692	695	695	695	689	691	691	688	689	693	694	697	691	695
Adults	Pearson Correlation	-,059	,028	,013	,007	-,069	-,012	-,056	,083*	-,089*	-,007	-,025	-,048	,001	,024	-,275**	-,189**	1	-,146**
	Sig. (2-tailed)	,122	,468	,726	,854	,070	,747	,141	,029	,020	,863	,509	,211	,986	,534	,000	,000		,000
	N	692	692	689	687	687	690	690	690	684	686	686	683	684	688	689	691	692	691
Elderly	Pearson Correlation	-,040	-,018	-,014	-,014	,014	,001	,021	,069	,007	,066	,008	,011	,002	-,019	,126**	,110**	-,146**	1
	Sig. (2-tailed)	,289	,627	,721	,717	,709	,987	,575	,069	,849	,081	,830	,765	,951	,622	,001	,004	,000	
	N	697	697	694	692	692	695	695	695	689	691	691	688	689	693	694	695	691	697

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

SPPS Output of Multiple Regression Analysis for Expanded Model Predicting Self-protective Intention

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95,0% Confidence Interval for B Lower Bound	95,0% Confidence Interval for B Upper Bound
1	(Constant)	3,309	,083		40,059	,000	3,147	3,471
	Age	,008	,002	,134	3,539	,000	,004	,012
2	(Constant)	,587	,237		2,474	,014	,121	1,053
	Age	,004	,002	,068	2,173	,030	,000	,008
	SelfEfficacy	,548	,042	,513	12,896	,000	,465	,631
	OUPositiveOutcome	,028	,039	,027	,718	,473	-,049	,105
	OUPerceivedBarriers	-,008	,030	-,010	-,278	,781	-,067	,051
	RP_susceptibility	,053	,043	,050	1,237	,216	-,031	,138
	RP_severity	,070	,041	,066	1,696	,090	-,011	,150
	EnvRiskPerception	,058	,044	,048	1,303	,193	-,029	,145
3	(Constant)	,552	,264		2,088	,037	,033	1,070
	Age	,004	,002	,064	2,056	,040	,000	,007
	SelfEfficacy	,501	,044	,469	11,489	,000	,415	,586
	OUPositiveOutcome	,049	,039	,046	1,250	,212	-,028	,125
	OUPerceivedBarriers	-,018	,030	-,020	-,587	,558	-,077	,041
	RP_susceptibility	,036	,043	,034	,837	,403	-,048	,120
	RP_severity	,028	,043	,027	,654	,513	-,056	,112
	EnvRiskPerception	,056	,044	,047	1,268	,205	-,031	,142
	GovernmentalTrust	,012	,031	,012	,394	,694	-,049	,074
	Info_Gov	,090	,025	,132	3,637	,000	,042	,139
	Info_Media	,023	,029	,030	,809	,419	-,033	,080
	Info_Family	-,041	,027	-,052	-1,533	,126	-,093	,011
	ShortnessBreathOutside	,058	,027	,076	2,133	,033	,005	,111
	NoseAllergy_Me	-,002	,024	-,003	-,075	,940	-,048	,044

a. Dependent Variable: SelfProtectiveIntention

SPSS Output of Two Step Multiple Regression for Complete Model Predicting Environmentally Friendly Intentions.

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	1,112	,296		3,757	,000
	SelfEfficacy	,247	,053	,214	4,638	,000
	OUPositiveOutcome	,140	,049	,123	2,850	,005
	OUPerceivedBarriers	,011	,038	,012	,301	,764
	RP_susceptibility	,098	,054	,084	1,822	,069
	RP_severity	,029	,052	,025	,553	,580
	EnvRiskPerception	,110	,055	,085	1,986	,047
2	(Constant)	,534	,329		1,622	,105
	SelfEfficacy	,210	,055	,182	3,829	,000
	OUPositiveOutcome	,154	,049	,134	3,126	,002
	OUPerceivedBarriers	,021	,038	,022	,547	,585
	RP_susceptibility	,095	,053	,082	1,776	,076
	RP_severity	,021	,054	,018	,395	,693
	EnvRiskPerception	,121	,055	,093	2,199	,028
	GovernmentalTrust	,150	,039	,139	3,826	,000
	Info_Gov	,041	,031	,054	1,302	,193
	Info_Media	,016	,036	,019	,440	,660
	Info_Family	,030	,034	,035	,890	,374
	ShortnessBreathOutside	,031	,034	,038	,916	,360
	NoseAllergy_Me	-,017	,030	-,024	-,591	,554

a. Dependent Variable: EnvironmentallyFriendlyIntention