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ORIGINAL PAPER

Consumers' purchase intentions toward products against city smog: exploring the influence of risk information processing

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Abstract This research focuses on consumers' purchase intentions related to products that deal with city smog. A conceptual model of consumers' risk information processing and purchase intentions toward protective products was developed. Results showed that, in the context of city smog, consumers' purchase intentions toward protective products are significantly influenced by their information processing, risk perception, knowledge of city smog, and advice from government and non-government sources. Unlike government advice, vice from non-government sources plays a more important role in consumers' systematic processing and risk perception than in their heuristic processing. In addition, we find that the herd effect influences consumers' purchase behavioral intentions.

Keywords City smog knowledge · Information processing · Risk perception · Subjective norm · Purchase behavioral intentions

1 Introduction

Smog typically forms in cities where vehicle emission and energy consumption levels are high (Saraf et al. 2011; Li and Qiao 2015) and can seriously affect traffic and human health (Yue et al. 2016). In recent years, China has experienced increased large-scale smog. The high levels of PM2.5 (i.e., particulate matter with a diameter of 2.5 microns or less and serves as the main component of smog) have become a growing public concern (Li and Liu 2014) that has caught the attention of scholars. High concentrations of PM2.5, which are

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harmful to human health, can cause various diseases, such as upper respiratory tract infection, bronchial asthma, and cancer. In a report released on October 17, 2013, the International Agency for Research on Cancer under the World Health Organization reported that air pollution can be considered one of the biggest threats to our environment and that PM2.5 is a particularly important cause of such pollution.

People who frequently experience city smog pay close attention to self-protective measures, such as the use of anti-city smog products (Yaday and Pathak 2016). Thus, the laws that govern the selling and purchasing of anti-city smog products are worth investigating. According to Lindell and Perry (2012), from the perception of risk information processing, studying self-protective measures, such as buying anti-city smog products, is crucial (Wei et al. 2016a, b). To understand consumers' purchase behaviors in this aspect, we must investigate how people obtain information related to city smog, how they process the information, and how they use such information to make decisions related to their self-protection.

Extant research on individuals' self-protective actions in the context of city smog focuses on the formation and characteristics of smog (HaagenSmit 1952; Kim et al. 2007; Cao and Jiang 2014), the harm it brings to the environment and human health (Bell et al. 2004; Beeson et al. 1998; Chen et al. 2014), and the methods for preventing and controlling it (Repetto 1987; Foster and Hahn 1995; Wang and Sun 2016). In recent years, serious city smog has appeared in large areas in China for long time periods, thereby hindering the development of Chinese economy to some extent (Shi et al. 2016; Zhou and He 2015; Sun et al. 2016). In this context, Shi et al. (2016) suggested that developing countries like China should learn rapidly from industrialized countries with regard to effective measures to combat city smog. Sun et al. (2016) proved that household income and government credibility can positively influence people's behavioral responses to city smog. In a comparative study between two cities, Wei et al. (2016a, b) revealed that an individual's protective behavior toward smog is influenced by many factors and is mediated by risk perception. However, few scholars have empirically examined how external fog and haze can affect people's self-protective behaviors in the context of areal city smog. Thus, the present work attempts to fill the research gap, with the aims of providing support for the development of policies related to smog mitigation and expanding our understanding of individual self-protective actions.

In the current study, the Protective Action Decision Model (PADM) framework is employed to examine information processing in individuals' responses to city smog risk (Lindell and Perry 2012). People who live in cities suffering from smog face different city smog risks (Cheng et al. 2017). The heuristic–systematic model (HSM) of information processing posits that individuals employ two types of message processing routes, namely heuristic processing and systematic processing (Eagly and Chaiken 1993). This theory is employed in this study to classify people's information processing patterns into two types and evaluate the respective influences of such patterns on intentions to purchase self-protective products. Moreover, we attempt to understand the effect of external pressure or advice on people's self-protective actions. According to theory of planned behavior (TPB) (Ajzen 1991), subjective norms serve as an important variable that can significantly affect behavioral intention. We further divide external advice into governmental and non-governmental advice to investigate their respective influences on individuals' self-protective actions. The results can provide deep insights into people's self-protective actions, such as purchasing air purifiers or anti-smog masks, under the city smog scenario.

The rest of this paper is organized as follows. Section 2 reviews the conceptual background of the critical variables used in this study. Sections 3 and 4 provide details about

the methodology, including the data analysis and results. Section 5 discusses the conclusions as well as their theoretical and practical implications.

2 Theoretical framework

In this research, three theoretical perspectives are used to explain information processing in relation to individuals' risk perception and protective responses, such as purchasing air purifiers and wearing anti-air-pollution clothing and masks.

The PADM is an integrated framework that is universally applied in the research on public response to threatening events, such as disasters and environmental hazards (Lindell and Perry 1992; Wei et al. 2016a, b). This framework posits that people who are exposed to real or potential risks receive external warning messages or information, which contributes to their risk perceptions that eventually result in protective behavior intention (Lindell et al. 2005). This model has constantly been developed and improved since its introduction. In the updated PADM model, several stages of information processing are identified (reception, attention, comprehension of warnings or exposure, attention, and interpretation of environmental/social cues), and such stages are deemed relevant to the household adoption of individual protective actions (Lindell and Perry 2012), including typical psychology, body activity performed, a series of questions asked, and outcome in each stage. Recently, the updated PADM model has been applied in health and risk communication programs that cover such areas as earthquakes, tsunamis, flood hazards, and other specific situations like anti-nuclear behavioral intention (Zhu et al. 2016) and product recall (Wei et al. 2016a, b). All factors and comprehensive information flow into the updated PADM model (Lindell and Perry 2012). Therefore, this new model could be highly useful to analyze behavioral intention in the decision-making process and understand crisis communication before the conduct of protective actions (Lindell and Perry 2012).

The PADM framework is widely used in risk communication, evacuation modeling, as well as long-term and hazard adjustment (Lindell and Perry 2012). Its application can also be extended to anti-smog scenarios for the following two reasons. First, city smog is a hot topic in China because of the harm it brings to human health (China Meteorological Bulletin 2015).[1] Residents living in cities with heavy smog are anxious about the potential threats of city smog to the environment and their health (Wei et al. 2009). Therefore, city smog can be viewed as an event that is likely to affect the risk perception of local residents. Second, residents receive city smog information through various channels, assess the risks synthetically, and decide whether to take protective actions, such as purchasing air purifiers (Lindell and Perry 2012). Therefore, incorporating information flow into the PADM is appropriate to investigate individuals' intentions to purchase anti-city smog products.

However, the PADM does not include detailed information processing that may determine the final effect of risk communication on people's protective action decisions (Smerecnik et al. 2012; Johnson 2005). According to the HSM of information processing (Chaiken 1980; Eagly and Chaiken 1993), a person handles messages in two ways: heuristic processing and systematic processing, which lead to different risk information processes and risk judgment (Smerecnik et al. 2012). The HSM model has been applied to the investigation of individuals' judgment of risk situations (Griffin et al. 1999; Trumbo 1999). According to the literature on individuals' risk information processing, an increasing number of scholars recognize the potential and value of the HSM (Kahlor et al.

[1] http://zls.mep.gov.cn/hjtj/qghjtjgb/201510/t20151029_315798.htm.

2003; Kim and Paek 2009; Smerecnik et al. 2012; Wei et al. 2016a, b), because the HSM provides a strategic framework that allows us to effectively understand how individuals seek, receive, process, and handle external information in the face of risks; furthermore, the HSM further helps us understand individuals' risk communication processes and protective behaviors (Griffin et al. 1999; Wei et al. 2016a, b). Therefore, in the present study, we integrate the PADM and HSM to investigate individuals' protective intentions in the context of city smog risk.

According to TPB (Ajzen 1991), individuals' behavioral intentions are jointly influenced by three factors: attitude, subjective norms, and perceived behavioral control. The TPB model is a useful theoretical framework that exerts a strong forward-looking effect on a wide range of individual behaviors (Abou-Zeid and Ben-Akiva 2011; Witzling et al. 2015) and helps us understand the influence of individual behavioral intention and determinants through the integration of social surroundings into self-volitional determinants (Han et al. 2010). Subjective norms refer to an individual's perception of social pressure to perform certain behavior (Ajzen 1991). Considering our research context, we divide social pressure into government advice and non-government advice to refine our prediction of individuals' protective behavioral intention.

We integrate the updated PADM, HSM, and TPB model into our research so as to provide a comprehensive conceptual framework through which we can discuss individuals' intentions to purchase anti-city smog products as a form of protection against city smog. The research model, shown in Fig. 1, assumes that city smog information influences individuals' risk perception and their information processing and that such information is induced by risk perception itself based on government and non-government advice, thereby stimulating individuals' behavioral responses. Next, we discuss the proposed constructs and hypotheses of the conceptual model in detail.

2.1 Knowledge of risk

People hold different views in comprehending special objects (Lindell and Perry 2012). Knowledge derived from a mixture of research, work, educational, and personal experiences always plays an important role in decision making (Fazey et al. 2006). In this study, we mainly use subjective knowledge (Brucks 1985) to describe individual cognition. People's experientially derived knowledge and abstract knowledge influence their opinion and behavior jointly. One can assimilate knowledge by conceptualizing the environment and attaching values to it (Roder et al. 2016). Previous research deemed that risk estimation is correlated with previous personal experience and personality or traits (Gavilanes-Ruiz et al. 2009). According to the PADM, individuals' risk perceptions and behavioral responses are usually related to the recency and intensity of their previous experiences with risks and events (Lindell and Perry 2012). The knowledge of risk (e.g., risk experience) can create a type of cognitive bias, which results in a relatively high rate of risk perception about potential or real dangers (Grothmann and Patt 2005; Wei et al. 2016a, b).

According to the literature on environmental risks, personal knowledge of risk plays an important role in perception, in addition to stimulating people to make decisions about protective actions (Whitmarsh 2008; Wei et al. 2016a, b). For example, in their study on how to measure the risk perception of air pollution, Deguen et al. (2012) suggested that risk knowledge (e.g., life experiences, outside world knowledge) greatly affects the assessment of risk perception of air pollution. As described by Whitmarsh (2008), people's knowledge concerning the health effects of air pollution augments their risk perception and protective behavioral response to climate change. Johnson (2012) suggested that people with

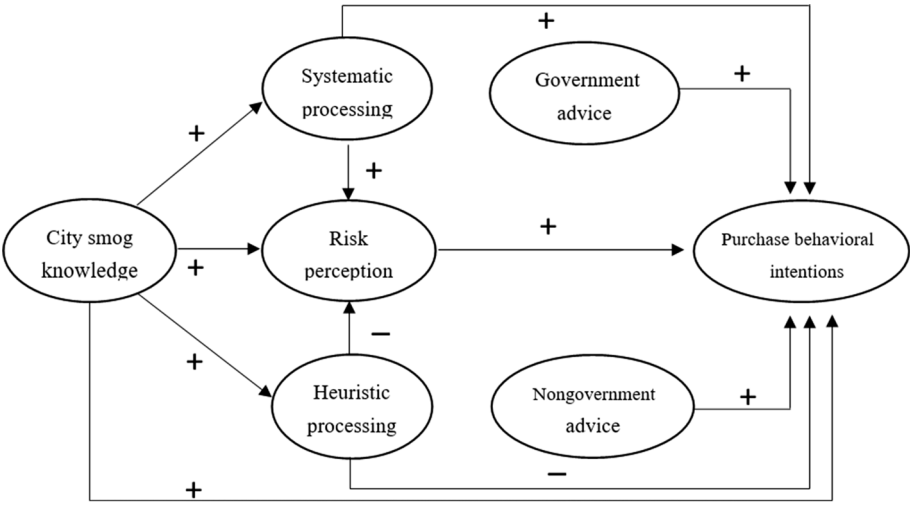

Fig. 1 Hypothesized model of individuals' responses to the anti-city smog

respiratory problems or heart illnesses are vulnerable to air pollution and tend to reduce outdoor activities to protect themselves from air pollution, even though the outcome is usually not good. However, only a few studies have focused on the influence of city smog knowledge on individuals' intention to purchase air cleaners to protect themselves from air pollution. Therefore, we attempt to fill this gap in this study.

2.2 Risk perception

Extant empirical studies on risk perception revolve around three subjects: probability assessment, utility assessment, and decision-making processes (Edwards 1961; Arrow 1982; Slovic 1987). To understand risk perception, we should first recognize that "risk" itself as a word carries several meanings, such as technical, colloquial, or intuitive meanings (Jardine and Hrudey 1997). In this research, the scope of risk perception includes qualitative "outrage factors" (Lindell and Hwang 2008), such as dread, outrage, and unknown risks (Slovic et al. 2001). According to the PADM, risk perception is a critical variable that affects an individual's responses to an extreme environmental event and prompts them to form a different understanding of such event (Lindell and Hwang 2008). Risk perception denotes individuals' perceptions about the information from environmental cues that produce specific physical and social impacts, thus influencing their protective behavioral intentions and responses (Lindell and Perry 2012; Cheng et al. 2017).

Buying self-protective products is an important protective behavior. Aside from the PADM, many conceptual frameworks have been utilized to explain why and how households take protective actions (Lindell et al. 2004). Some researchers have investigated the direct relationship between individuals' risk perception and their property, safety, or health (Burton et al. 1978; Lindell and Hwang 2008). For example, Lindell and Hwang (2008) suggested that after accepting risk information, people's behavior of purchasing flood insurance or elevating their house above the base level can be regarded as a kind of hazard adjustment adopted to protect themselves from floods. In the present study, we

attempt to investigate whether risk perception exerts a significant effect on behavioral intentions in the city smog scenario.

2.3 Information processing

According to the HSM, heuristic and systematic processing are two concurrent types of cognitive information processing (Kim and Sundar 2016), which are regarded as an antecedent to people's attitude formation and response behavior (Wei et al. 2016a, b). On the one hand, in systematic processing, an individual makes a judgment by carefully examining information and relating it to the information that is already available (Reference). On the other hand, in heuristic processing, individuals often use simple peripheral cues without additional effort to help them make judgments in relation to a specific message (Trumbo 2002). On the basis of this theory, we assess the procedure of city smog information processing along two dimensions: heuristic processing and systematic processing. Specifically, individuals with different information processing strategies deal with smog information in different ways. These processes can eventually lead to distinct decisions on purchasing air purifiers or anti-city smog masks.

Prior research shows that individuals' inherent knowledge structures exert important effects on their information processing (Bettman and Park 1980). According to the HSM, previous knowledge is a core factor that influences information processing (Eagly and Chaiken 1993; Trumbo and McComas 2003; Zhao and Hu 2015). For example, Trumbo and McComas (2003) found that individuals' prior knowledge is associated with motives of processing information. Zhao and Hu (2015) tested the role of individuals' knowledge in information processing and concluded that knowledge is a determinant factor that influences people's information processing strategies.

In the field of HSM research, scholars have examined the role of information processing in individuals' risk judgments (Trumbo 2002; Zhao and Hu 2015; Zhu et al. 2016). For example, Zhu et al. (2016) revealed that systematic processing exerts a positive effect on individuals' risk perception. Similarly, Ryu and Kim (2015) investigated the relationship between information processing and risk perception in the context of the Fukushima nuclear accidents. However, studies on the application of the HSM in a real-life context are limited (Ryu and Kim 2015). Therefore, in the present study, we endeavor to further explore the interaction between the HSM and risk perception in the empirical context of city smog in China.

2.4 Subjective norms

Although previous research on crisis has shown that the behaviors of others play an important role in people's evacuation decisions, few PADM research have explicitly investigated the concept of "subjective norm" (Lindell and Perry 2012). In TPB, subjective norms are an independent social factor that refers to one's perceived social pressure to perform or not to perform a certain behavior (Ajzen 1991). According to TPB, a favorable subjective norm equates to a strong intention to perform a certain behavior in a special condition (Ajzen 1991; Hrubes et al. 2001; Wang and Fan 2014). Wei et al. (2015) suggested that individuals obtain information about city smog in China from two different sources, namely government sources (e.g., local TV, government officials, national news Web sites, environmental protection agency experts) and non-government sources (e.g., friends, relatives, neighbors, community bulletin boards). Therefore, social groups can exert a considerable effect on individuals by providing opinions or suggestions.

Recently, research on consumers' purchase intentions has paid close attention to the influencing factor of "trust." Trust is suggested to influence individuals' judgments of various types of risks (Dholakia 2001; Pavlou 2003; Pavlou and Gefen 2004; Das and Teng 2004; Wachinger et al. 2013; Dai et al. 2015) and to play an important role in the communication of information about the environment to the target audience (Brewer and Ley 2013; Han et al. 2017). Moreover, local and central governments in China play a decisive role in managing city smog and other environmental issues. The government, in particular, cannot govern itself, resulting in credibility issues (Evans 2012). The external recommendations regarding city smog that individuals receive can be classified into government and non-government suggestions. In the present study, we operationalize "subjective norms" as government suggestions and non-government suggestions so as to test their actual effects on individuals' responses to city smog.

2.5 Behavioral intentions

In the PADM, behavioral response posits that people generate a behavioral response, such as purchasing bottled water and canned food, making evacuation plans, or reinforcing walls (Perry et al. 1982; Russell et al. 1995) when confronted with environment hazards or disasters (Lindell and Perry 2012). In marketing research, behavioral intention is a more accurate predictor of behavior in comparison with other determinants (Wang and Fan 2014). According to Schuitema et al. (2013), actual adoption behavior is not easy to measure accurately. Moreover, air purifiers or anti-city smog masks are novel products to most Chinese consumers. According to Ajzen (1985, 1991), "the stronger the intention to engage in a behavior, the more likely should be its performance." Thus, we use behavioral intention as a proxy of consumers' actual purchase behavior and employ the PADM theoretical framework to study it.

In previous air pollution research, scholars found that usual protective behaviors involve closing windows, reducing outdoor activities, avoiding traffic jams (Day 2004; Johnson 2012), and moving to smog-free areas to work and reside. However, ensuring complete protection from air pollution appears almost impossible (Bush et al. 2001). The situation is especially complex in China. On the one hand, severe nationwide city smog is a common occurrence (e.g., it occurred 11 times in 2015) and is thus difficult to avoid (China Meteorological Bulletin 2015). On the other hand, according to Wei et al. (2015), Chinese people are often reluctant to move from one city to another even if the latter has no city smog because of the high costs (i.e., time, effort, money) and the immigration barriers under environmental events, such as city smog condition, which are also observable in Western societies (Philip Martin 2003). Therefore, to most people, purchasing self-protective products is a feasible protection measure to handle environment issues. In this study, we use an indoor air purifier priced at USD 400 and an outdoor anti-city smog mask priced at USD 15 as examples to demonstrate individuals' purchasing of self-protective commodities. Specifically, we examine whether purchasing intention is influenced by city smog knowledge, information processing, risk perception, and government and non-government advice.

3 Methodology

3.1 Measurement development

In this study, we conducted a questionnaire-based survey to explore customers' behavioral intention of purchasing air purifiers and anti-smog masks as a response to city smog in China. The measurements for each construct were adapted mainly from existing research, but were modified to fit the research context. Specifically, in the preliminary stage, we reviewed the related literature to obtain the seminal scales of reference variables.

First, as mentioned above, the knowledge of city smog is necessary for individuals to make good responses to city smog risk. However, measures to assess city smog knowledge are lacking in previous studies, although some scholars have measured individuals' "understanding [of] the city smog" (Mason et al. 2001; Wei et al. 2016a, b). Thus, in the present study, we modified Mason's knowledge measurement scale and provided a new four-item measurement to understand consumers' self-evaluation of their knowledge of city smog risk (Park et al. 1988). Second, risk perception plays an important role in the PADM theoretical framework (Lindell and Perry 2012) and is used to analyze consumers' intention to purchase anti-city smog products. Therefore, we adapted the scale used by Wei et al. (2016a, b) to measure consumers' risk perception in this study. Third, individuals employ two types of information processing, namely heuristic processing and systematic processing (Trumbo 2002), under the city smog scenario. In this work, we measured heuristic processing and systematic processing according to the "Smerecnik Scale" (Smerecnik et al. 2012). Fourth, according to TPB, social pressures (subjective norms) affect individuals' purchase intention, and different people might have different opinions (Taylor and Todd 1995). In our study, we treated government advice and non-government advice as external social pressures and proceeded to test their effects on consumers' purchase intentions. We used the question "Do you believe that they (i.e., government or non-government sources) proposed the purchase of anti-city smog products?" (Lindell and Hwang 2008; Han et al. 2010). We adapted the measurements of Wei et al. (2015) and then proposed scales for government and non-government advice. Fifth, according to Ajzen (1991), consumers' behavioral intentions immediately determine actual behaviors. Thus, we referred to the measurements of purchase intention proposed by Pavlou and Gefen (2004), Yang et al. (2010), and Wang and Fan (2014).

After obtaining the initial measurements, we interviewed those who were familiar with the research context to contextualize the items. Then, an expert review was conducted to refine the wording of the instrument items. Their feedback provided the basis for revising the construct measures and modifying the wordings and item sequence. The final set of items and the corresponding sources are provided in Table 1. For all measurements, a five-point Likert-type scale with scores ranging from "strongly disagree" to "strongly agree" was employed. We first developed a questionnaire in English. Due to the research context (i.e., China), we translated the questionnaire into English. A back-translation method was used to ensure the equivalence of meaning.

In the beginning of the questionnaire, we introduced the scenario of air pollution to help the participants understand the context of the questionnaire. The background mainly includes the city smog contributing factor (i.e., PM2.5), harmful effects (i.e., respiratory disease and cancer), and the efforts to control city smog, such as the target of air pollution control put forward by the Chinese government in 2016–2010 (The Thirteenth Five-Year

Table 1 Questionnaire items

Constructs	Items	Measurement	References
City smog knowledge	CK1	I know city smog	Mason et al. (2001), Wei et al. (2016a, b), Park et al. (1988).
	CK2	I know city smog more than other people around me	
	CK3	I read about city smog newspapers or websites	
	CK4	I spend more time in research of city smog than others around me	
Risk perception	RP1	City smog threatens personal psychological and physical health	Wei et al. (2015)
	RP2	City smog threatens personal and family daily life	
	RP3	City smog threatens my work efficiency and performance	
	RP4	City smog threatens my possession	
Systematic processing	SP1	I connect the action what I myself might take to what I read	Smerecnik et al. (2012), Wei et al. (2016a, b)
	SP2	I connect city smog information to other information what I read or heard	
	SP3	I compare the city smog information to other things I know	
	SP4	I think about the importance of the city smog information for my health and daily life	
Heuristic processing	HP1	I only get a general of city smog information	Smerecnik et al. (2012).
	HP2	I only take little time to think about the city smog information	
	HP3	I think the city smog information unavailable for myself making decision	
	HP4	I only do very little effort to compare the city smog information to other things I know	
	HP5	The city smog information often contain too many conflicting viewpoints.	
Government advice	GA1	Experts in the field of environmental protection	Lindell and Hwang (2008), Han et al. (2010), Wei et al. (2015).
	GA2	The head of the government's environmental protection agency	
	GA3	State-owned enterprises of manufacturing anti city smog products	
	GA4	Government spokesman	
	GA5	Official media	

Table 1 continued

Constructs	Items	Measurement	References
	GA6	Government leadership in the region	
Non-government advice	NGA1	My relatives, friends, colleagues	Lindell and Hwang (2008), Han et al. (2010), Wei et al. (2015)
	NGA2	My immediate family	
	NGA3	My net friend	
	NGA4	My neighbor	
	NGA5	Other people who have no conflicts of interest with me	
Purchase behavioral intentions	PI1	I am willing to purchase the air purifier or anti-city smog mask in the near future	Pavlou and Gefen (2004), Yang et al. (2010), Wang and Fan (2014).
	PI2	I am think about purchasing the air purifier or anti-city smog mask	
	PI3	I have already decided to purchase the air purifier or anti-city smog mask in the near future	
	PI4	I think that it is quite necessary to purchase the air purifier or anti-city smog mask in the near future	

Plan for National Economic and Social Development of the People's Republic of China 2016).

3.2 Data collection

Survey data were gathered nationwide in China. A professional online survey platform, Wenjuanxing (http://www.sojump.com/), was utilized. The survey platform allowed us to generate an online questionnaire and a URL to visit it. Anyone could take the survey through the online questionnaire page. The online survey was open for a month. The participants were offered a lucky draw. As total of 802 participants took part in the survey, but 24 of them failed to finish the questionnaire. Eventually, we received 752 valid responses at a response rate of 93.8%.

Table 2 shows the demographic information of the respondents, including age, gender, residence history, education, annual income, and occupation. A dummy variable was used

Table 2 Demographic profile of participants ($N = 752$)

Variable	*N*	%
Gender		
0 = Male	349	0.46
1 = Female	403	0.54
Age (years old)		
1 = under 20	22	0.03
2 = 20–30	388	0.52
3 = 31–40	273	0.36
4 = 41–50	49	0.07
5 = over 50	20	0.02
Year(s) of residence		
1 = Less than 1	29	0.04
2 = 1–5	225	0.30
3 = 6–10	116	0.15
4 = 11–20	99	0.13
5 = over 20	283	0.38
Education		
1 = high school and lower	32	0.04
2 = junior college and bachelor degree	598	0.80
3 = master degree and above	122	0.16
Annual income (CNY)		
1 = less than 30,000	220	0.29
2 = 30,001–70,000	189	0.25
3 = 70,001–120,000	205	0.27
4 = 120,001–200,000	101	0.13
5 = 200,000 and higher	37	0.06
Job		
1 = official institute	144	0.19
2 = private company	396	0.53
3 = student	190	0.25
4 = others	22	0.03

to indicate gender (0 = male, 1 = female). A discrete variable was used to measure age, residence history, educational level, annual income, and occupation.

4 Data analysis and results

The data were collected from participants from 31 provinces and cities in China. We used multivariate methods to analyze the data and then tested each person's purchase intention as a response to city smog. Following the two-step approach recommended by Anderson and Gerbing (1988), we first examined the measurement model to verify the reliability and validity of the instruments, after which we assessed the structural model. Covariance-based structural equation modeling (CBSEM) was used for hypothesis testing and scale validation. The AMOS 22.0 software package was utilized to run the test.

4.1 Measurement model test

We referred to the work of Hu and Bentler (1999) in testing the reliability and validity of the constructs: Tucker–Lewis index (TLI) and comparative fit index (CFI) values ≥ 0.90; root-mean-square error of approximation (RMSEA) with 90% confidence interval (CI) values ≤ 0.08; and standardized root-mean-square residual (SRMR) with 90% CI values ≤ 0.10. According to Kline (2015), the results should meet the required Chi-square value divided by the model's degrees of freedom (χ^2/df) ≤ 5. We used Cronbach's alpha values and composite reliability values to assess the construct reliability (Fornell and Larcker 1981). If these values were higher than 0.70, reliability was deemed acceptable. In addition, average variance extracted (AVE) was used, with a value ≥ 0.50 signifying construct reliability (O'Leary-Kelly and Vokurka 1998).

The CFA results indicate a good fit between measurement model and the dataset ($\chi^2 = 1142.738$, $df = 419$, $\chi^2/df = 2.727$; TLI = 0.914, CFI = 0.927; RMSEA = 0.048, SRMR = 0.061). As shown in Table 3, the values of composite reliability range from 0.823 to 0.907, and the Cronbach's alpha values of the constructs range from 0.711 to 0.877, all of which are greater than 0.70. Furthermore, in Table 3, the proportion of variance explained (R^2) is over 0.40. Some scholars suggest that R^2 can be regarded as another indicator of reliability and requires a value of more than 0.40 (Carr and Pearson 1999; Kristal et al. 2010; Wei et al. 2016a, b). Thus, the construct reliability is acceptable.

Next, we tested the construct validity. According to the results of the CFA, the AVE values range from 0.54 to 0.674, which exceed 0.5, thereby indicating convergent validity. Discriminant validity was also tested. Some scholars suggest that a comparison between correlations among constructs and the square roots of AVE values can reflect discriminant validity (Chiu and Wang 2008; Wang and Fan 2014). As shown in Table 4, the square roots of the AVEs for each construct are all greater than the inter-construct correlations depicted in the off-diagonal entries; thus, the model achieves sufficient discriminant validity. On the basis of the above analysis, we conclude that the measurement model fits the data well.

4.2 Structural model test

Path analysis with structural equation modeling was employed to examine the path coefficients in the model after the measurement model test. Figure 2 presents the results of the

Table 3 Results of the confirmatory factor analysis

Items	Predictor	Factor loading	S.E.	C.R.	p	R^2	Composite reliability	Cronbach's alpha value	AVE
CK1	CK	0.584				0.539	0.892	0.836	0.674
CK2		0.694	0.1	12.795	***	0.726			
CK3		0.854	0.163	11.441	***	0.724			
CK4		0.838	0.166	11.242	***	0.707			
RP1	RP	0.538				0.472	0.834	0.731	0.558
RP2		0.657	0.096	11.777	***	0.592			
RP3		0.725	0.113	11.538	***	0.628			
RP4		0.616	0.114	10.933	***	0.539			
SP1	SP	0.683				0.61	0.823	0.711	0.54
SP2		0.607	0.071	13.75	***	0.556			
SP3		0.69	0.084	13.674	***	0.601			
SP4		0.505	0.075	11.008	***	0.394			
HP1	HP	0.595				0.513	0.881	0.829	0.597
HP2		0.666	0.075	15.414	***	0.6			
HP3		0.721	0.099	11.875	***	0.62			
HP4		0.764	0.096	12.276	***	0.663			
HP5		0.71	0.091	12.923	***	0.586			
GA1	GA	0.6				0.485	0.907	0.877	0.62
GA2		0.758	0.083	16.931	***	0.663			
GA3		0.643	0.081	13.895	***	0.502			
GA4		0.834	0.099	15.634	***	0.722			
GA5		0.746	0.093	14.571	***	0.628			
GA6		0.839	0.098	15.947	***	0.718			
NGA1	NGA	0.709				0.598	0.857	0.787	0.547
NGA2		0.662	0.064	15.871	***	0.501			
NGA3		0.824	0.115	12.016	***	0.452			
NGA4		0.709	0.096	11.577	***	0.691			
NGA5		0.499	0.084	10.045	***	0.493			
PI1	PI	0.553				0.555	0.87	0.799	0.626
PI2		0.767	0.122	14.357	***	0.658			
PI3		0.86	0.153	14.289	***	0.713			
PI4		0.579	0.087	13.973	***	0.578			

S.E. are standard error values. C.R. are critical ratio values

*** $p < 0.01$

structural model using the software package AMOS 22. The results indicate that the structural model fits the data well ($\chi^2 = 1031.719$, df = 411, χ^2/df = 2.510; TLI = 0.925; CFI = 0.937; RMSEA = 0.045, SRMR = 0.056). Then, we obtained the parameters, including R^2, β (path coefficients), and t (critical ratio, same as the t test).

As shown in Fig. 2, the data statistically support most of the hypothesized framework. Consumers with high levels of city smog knowledge usually employ high levels of

Table 4 Means, standard deviation (SD) and correlations

	Means	SD	CK	RP	SP	HP	GA	NGA	PI
CK	3.342	0.895	**0.821**						
RP	3.792	0.689	0.266***	**0.747**					
SP	3.893	0.604	0.393***	0.272***	**0.735**				
HP	2.601	0.871	−0.299***	**−0.015**	−0.254***	**0.773**			
GA	3.387	0.821	0.376***	0.181***	0.293***	−0.133***	**0.787**		
NGA	3.403	0.408	0.389***	0.258***	0.386***	−0.131***	0.445***	**0.74**	
PI	3.322	0.406	0.431***	0.228***	0.415***	−0.318***	0.309***	0.393***	**0.791**

Means stand for average factor scores. The diagonal bold is the square roots of AVEs, and the off-diagonal elements are the correlations between constructs

*** $p < 0.01$

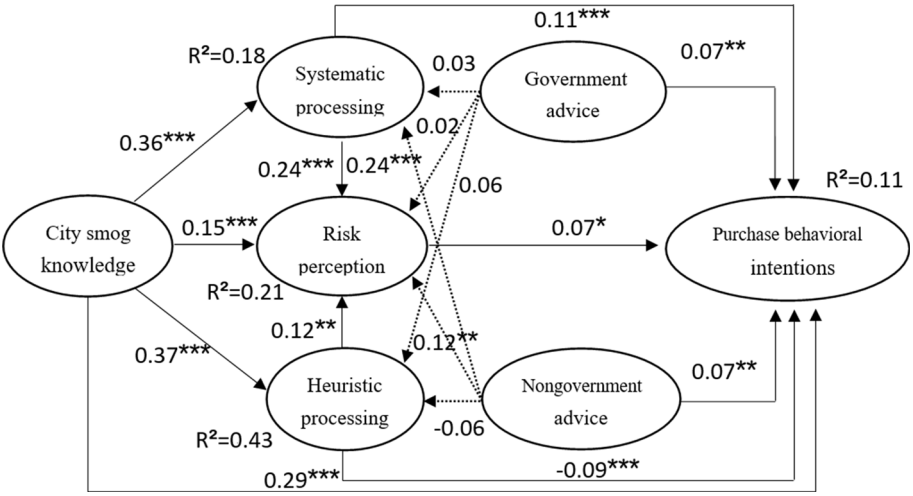

Fig. 2 Results of structural model $*p < 0.10$, $**p < 0.05$, $***p < 0.01$

systematic processing ($\beta = 0.36$; $t = 6.590$; $p < 0.01$) and heuristic processing ($\beta = 0.37$; $t = -4.633$; $p < 0.01$). Moreover, individuals with high levels of city smog knowledge possess high risk perception ($\beta = 0.15$; $t = 2.598$; $p < 0.01$) and purchase intentions ($\beta = 0.29$; $t = 5.796$; $p < 0.01$). High levels of systematic information processing also lead to high risk perception ($\beta = 0.24$; $t = 3.619$; $p < 0.01$) and behavioral intentions ($\beta = 0.11$; $t = 2.974$; $p < 0.01$). Correspondingly, the effect of systematic processing on risk perception is stronger than that of heuristic information processing ($\beta = 0.12$; $t = 3.155$; $p < 0.05$); heuristic information processing presents a significantly negative influence on consumers' purchase behavioral intentions ($\beta = -0.09$; $t = -3.098$; $p < 0.01$). In addition, risk perception ($\beta = 0.07$; $t = 1.891$; $p < 0.10$), government advice ($\beta = 0.07$; $t = 2.056$; $p < 0.05$), and non-government advice ($\beta = 0.07$; $t = 2.013$; $p < 0.05$) positively and significantly affect consumers' purchase intentions. An interesting result that cannot be mentioned in the hypothesis model is that the variables of non-government advice also exert a significantly positive influence on risk perception ($\beta = 0.12$; $t = 2.377$; $p < 0.05$) and systematic processing ($\beta = 0.24$; $t = 4.657$; $p < 0.01$), but that government advice does not have such effects. In the overall model, both government advice and non-government advice fail to affect heuristic processing. On the basis of the above analysis and Fig. 2, we can conclude that all of our hypotheses are supported, except for one path that links heuristic processing and risk perception.

5 Conclusions, implications, and limitations

5.1 Conclusions

In this research, the PADM was employed to examine consumers' intentions to purchase protective products in the context of city smog. This section presents the findings and conclusions.

City smog knowledge plays an important role in the study of consumers' purchase intentions in the city smog scenario. Consumers' protective behavioral intention of

purchasing anti-smog products may be related to their personal knowledge (e.g., experience) of city smog risk. As revealed by the analyzed results, individuals with extensive knowledge of city smog are not only stimulated to purchase protective products but are also prompted to show great risk perception. In other words, such knowledge poses a positive influence on their systematic or heuristic processing. These findings are consistent with the assertions of Mostafa (2009), Scott and Vigar-Ellis (2014), and Yaday and Pathak (2016) that consumers with high levels of environmental knowledge are confident in their decision making and are likely to purchase green products, such as air purifiers and anti-city smog masks.

Risk perception is a critical factor that links individuals' risk perception of city smog and individual's protective behavior. However, previous research has paid little attention to the role of risk perception in purchasing self-protective products in the city smog scenario. In the present study, the PADM theoretical framework was employed to examine the information processing of consumers' intention to purchase protective products. According to the PADM, individuals' risk perceptions of environmental threats are usually deemed to be probabilities and consequences (Slovic et al. 1980; Lindell and Perry 2012). As revealed in the results, consumers may make a positive judgment of the severity of a risk when they face the risk of city smog for the first time. Then, the perception of city smog risk exerts a positive and significant impact on individuals' self-protective behavior, as proved in this study.

Consumers' systematic or heuristic information processing presents significant influences on personal risk perception. Heuristic processing is negatively related to purchasing intentions, whereas systematic processing is positively related to it. This finding is of particular interest. Some research suggests that the HSM indicates whether systematic or heuristic processing may occur alone, mainly by someone engaged (Chen et al. 1999; Kim and Sundar 2016). As indicated by the results of the present study, both systematic and heuristic processing actively increase risk perception of city smog, that is, when people process city smog information, heuristic processing exerts a lower influence on risk perception than systematic processing. Furthermore, consumers with high levels of heuristic processing have little intention to purchase anti-city smog products. This finding indicates that, when consumers perform heuristic processing, their purchase intentions are not changed easily, even when they are exposed to intensive city smog information.

The results suggest that both government advice and non-government advice exert significantly positive influences on consumers' intentions to purchase self-protective products. As mentioned in the literature review, government advice and non-government advice originating from "subjective norms" were included in our model to test their effects on consumers' purchase behavioral intentions. According to TPB, subjective norms positively affect consumers' behavioral intentions (Axsen and Kurani 2012; Castanier et al. 2013; Wang and Fan 2014). Our result is consistent with this notion, but we divided "subjective norms" into government advice and non-government advice in our work to provide deep insights into the application of "subjective norms" in this context.

An interesting and equally important finding is that the non-government advice received by a person presents a positive effect on risk perception when this person performs systematic processing; meanwhile, government advice does not show the same effect. According to previous studies, public trust in the government has declined in developed and developing countries in recent years (Cooper et al. 2008; Kim 2010; Zhao and Hu 2015), prompting individuals to rely heavily on relatives, friends, colleagues, and other non-governmental sources for information. According to our results, individuals with systematic processing are likely to accept non-governmental advice and deeply elaborate relevant information; in such a case, their risk perception of city smog and intentions to purchase self-

protective products increase. Moreover, individuals' systematic processing makes perfect sense because their judgments—based on salient heuristics without significant mental effort—are made more rapidly in comparison with systematic processing. Thus, neither government nor non-government advice shows a direct significant influence on them.

Another interesting finding is that government and non-government advice have almost the same impact on individuals' purchase intentions, although the impacts on individuals' risk perception are quite different. This finding could be explained by the so-called herd effect or herd behavior (Scharfstein and Stein 1990; Banerjee 1992; Preis et al. 2010; Guo et al. 2016), which suggests that individuals interact with one another and tend to act in a similar manner as a result of such interactions. Consequently, they constitute a crowd in which individuals perform similar behaviors even if their own information suggests that they should do different things. Specifically, individuals are likely to be advised by their close and trustworthy peers to strengthen their risk perception and then finally decide to purchase products, such as air purifiers or anti-city smog masks. However, in this process, individuals' decision making related to purchasing intentions might be irrational.

5.2 Implications and limitations

The theoretical contributions of this work can be reflected in four aspects. First, this study extended the application boundary of the PADM theoretical framework. According to Lindell and Perry (2012), the PADM was originally used to analyze individuals' information flow and protective behavior when facing sudden disastrous events. In the current work, we employed the PADM to study risk information processing in the context of city smog, a type of environmental risk that does not occur suddenly. The results suggest that the PADM is valid in the context of long-term environmental damage. Second, investigating the impact of city smog knowledge on self-protective behavior is of great significance, but is largely unrecognized in the extant literature. Our research shows that individuals with high levels of city smog knowledge are likely to take spontaneous self-protective actions that they can afford, such as purchasing air purifiers or anti-city smog masks. Third, we employed the HSM to study information processing and responsive behaviors in the real-life context of city smog in China. We then obtained the coefficients between systematic and heuristic processing that influence risk perception and purchase behavioral intentions. The findings are consistent with previous research, which indicates that two types of information processing, namely systematic and heuristic processing, significantly influence risk perception. We add to this knowledge by revealing that, given the same piece of information, heuristic processing leads to a lower risk perception than systematic processing (Trumbo 1999; Johnson 2005). Fourth, in light of reality, we divided subjective norms into government and non-government advice to further investigate the influence of social pressure on individuals' intentions to purchase self-protective products. Previous research usually revolve around subjective norms as an independent variable (Ajjan and Richard 2008; Han et al. 2010; Ramayaha et al. 2012; Wang and Fan 2014). Our results show that non-government advice weighs heavily on individuals' decision-making processes. Few scholars have studied this topic before; hence, our findings would deepen our understanding of the HSM and TPB.

Our study also offers practical implications for those who want to understand consumers' purchase intentions for protective products, including governments and sellers of anti-city smog products. First, in the city smog context, individuals making rational and effective decisions related to the purchase of anti-city smog products mainly rely on their city smog knowledge, which may be obtained from previous experience, daily learning,

and other advice. Therefore, individuals should possess comprehensive knowledge about the subject of a decision-making process to avoid making blind and irrational decisions. Second, marketers of environmental products should pay attention to consumers' diverse knowledge of city smog. According to Lin et al. (2012), given different external information, individuals with different degrees of perceived risks might demonstrate different purchase intentions. For instance, in the city smog scenario, consumers with systematic processing usually pay close attention to external information. Thus, favorable product attitudes and high purchase intentions may be formed by this group of consumers. In this way, marketers can offer targeted sale schemes to each type of consumers. Third, marketers may carefully analyze and take advantage of the "herd effect" in consumers, encouraging customers to influence one another to enroll more buyers. According to our results, this strategy can be applied to all people who show a herd tendency under the city smog scenario. Fourth, governments should enhance public awareness of self-protection in city smog situations. According to our findings, the traditional and official method may not be the best one. Therefore, public administrators should change their traditional ways of spreading information. They can opt to use personalized and socialized media, such as social media sites, community bulletin boards, and private research institutions. In addition, governments should consistently pay attention to credibility issues.

Although this study arrived at some interesting findings, certain limitations need to be acknowledged and addressed through future studies. On the one hand, the samples for the questionnaire were collected from China. According to previous studies, differences in national cultures, such as an individualist culture (e.g., America) and collectivist culture (e.g., China), may affect the public's risk attitudes, thus causing a degree of "uncertainty avoidance" (Hofstede 2001; Sengupta and Zhou 2007). Therefore, future research should explore this aspect and deepen our understanding of risk perception and purchase behavioral intentions in the context of city smog. On the other hand, the present study only focuses on individuals' economic behavior of self-protective actions and uses the purchase of air purifiers or anti-smog masks to represent such behaviors. However, some common non-economic behaviors include "closing windows, reducing outdoor activity, avoiding traffic, concerning about health impacts" (Bickerstaff and Walker 1999; Johnson 2012). In addition, although the questionnaires with English items were translated into Chinese, biased comprehension may be unavoidable even with available methods to address it (i.e., inviting an English professor to translate the English items). Future studies should thus consider these matters and perform cross-cultural or cross-national and cross-single economic behavior research to enrich the conclusions of the current work.

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