科技部補助專題研究計畫報告

以巨量資料分析及多準則決策法萃取我國女性對PM2.5空氣品質之知覺、態度與政策偏好（重點代號：L02.4.探討災害防治、永續發展的社會和性別影響評估）（第2年）

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計 畫 主 持 人： 楊嘉麗
共 同 主 持 人： 許菁君、蔡惠峰

計畫參與人員： 助教-兼任助理：蕭一豪
助教-兼任助理：莊朝鈞
助教-兼任助理：蕭志梡
助教-兼任助理：安興彥
助教-兼任助理：王國肇
大專生-兼任助理：陳柏村
大專生-兼任助理：潘慧君
其他-兼任助理：陳思璇
其他-兼任助理：陳佳禾
其他-兼任助理：黃柏翰
其他-兼任助理：黃柏齡
其他-兼任助理：蒲郁文

本研究具有政策應用參考價值：□否 ■是，建議提供機關行政院環境保護署
（勾選「是」者，請列舉建議可提供施政參考之業務主管機關）
本研究具影響公共利益之重大發現：■否 □是

中　華　民　國　110　年　10　月　22　日

中 文 摘 要 ： 空氣品質為目前全球環境研究關注的議題焦點，其涉及健康、經濟、社會甚至政治動向，為深具實務價值之研究議題。過去學術界對空氣品質研究，多以探討氣候、汙染源粒子、監測技術、健康效果等為主，然近年來台灣空氣品質持續改善，但民眾空品滿意度卻未隨之增加，因此從社會科學角度關注群眾對空氣品質認知與態度議題，成為新興趨勢。其中女性在社會上之角色定位，經常與家庭、兒童、年長者安全有高度關聯，研究顯示國外女性對於環境意識高於男性，也相對在家庭與社區扮演行動發動者。因此了解女性對於空氣品質之認知、態度與政策偏好，將更有效將空污政策結合社區與家庭需求。 本計畫目的，為研究國人對空品認知與態度，著重於性別對於對空氣品質認知、態度是否有差異，並進一步分析女性對於空氣品質改善政策之選擇偏好。有鑑於目前關於性別與空氣品質環境認知研究有限，本研究採用多種巨量資料與決策分析方法，進行性別差異對空氣品質之認知、態度與政策偏好之探索性與驗證性研究。本研究分為四個階段，首先進行論文巨量資料探勘，從學術論文巨量資料庫，找出與空氣品質關聯度較高之學術論文，分析研究主題及其關聯性，發展空氣品質研究地圖。其次，進行社群媒體空品輿情分析，採用網路爬蟲、文字探勘、結構方程式等資料挖礦方法，將輿情資料結合至環境態度理論，探索國人對空氣品質關注議題、情緒與其調適策略。再者，透過約略集合、地理資訊方法，進一步了解不同性別，在空氣品質不同地域與議題上，是否有所差異。最後，依據上述研究成果，結合計劃行為理論，採用多準則研究方法，找出影響女性對於空氣品質態度與行為之關鍵因素，據此發展與選擇對應之政策工具。本研究結果發現，性別對於環境態度有影響，台灣女性普遍對空污認知與態度關注程度低於男性，尤其男性對於利己(如吸菸)或利他(如能源)類型對空污調適政策討論顯著高於女性，但若特定地域(如台中)或議題(如火力發電)視情況反之。在政策工具上，女性偏好公眾與私人部門參與之政策工具，建議決策者可將性別做為政策溝通、政策工具選擇方案之因子之一，並更積極提高台灣女性對環境認知與態度，藉此建構友善女性、家庭與社區之空氣品質政策。

中 文 關 鍵 詞 ： 空氣品質、環境態度、性別差異，社群媒體探勘，多準則決策分析，結構方程式, 環境政策工具

英 文 摘 要 ： Air pollution, which is the most pressing environmental problem in developing countries, is particularly bad in Taiwan, a country facing particularly difficult choices in balancing environmental protection with economic growth. With growing scientific evidence showing the harmful impact of air pollution on the environment and individuals' health in modern societies, public concern about air pollution has become a central focus of the development of air pollution prevention policy. Past research has shown that women are more aware of everyday hazards that often motivate social action because the significant differences exist in terms of knowledge, awareness, and attitudes towards air pollution than men. Despite close links between

air pollution and gender, there is a lack of studies on whether gender differences exist for general environmental perceptions and attitudes. A gender analysis of perceived environmental vulnerability is necessary. Seeing air pollution through women's eyes reflects women' specific needs and interest in air pollution. Thus, this research is for developing a research agenda on gender and air quality awareness, attitudes, and policy preferences from the perspective of gender difference in Taiwan. At first, this study introduces the research topic map to analyze the trends regarding to air pollution and gender difference studies. The Microsoft Academic Graph database is used to derive general publication as well as citation trends, evolution of research areas, and the relations between research areas being related to air pollution. Secondly, we construct a theoretical model by an integration of social media mining into a value-belief-norm (VBN) model of public concerns about air pollution. We propose a hybrid method integrating text mining, topic modeling, hierarchical cluster analysis and the partial least squares structural equation modelling (PLS-SEM). Third, we future explore the factors influencing females' attitudes toward air pollution by using GIS or rough set methods. Fourth, appropriate environmental education policy tools is defined to enhance female's attitude toward air pollution. A hybrid multi-criteria decision-making (MCDM) model, the DEMATEL Based Analytic Network Process integrated with the Modified Vikor (DANP-MV) is used. The results of this research project explore that females' knowledge should be utilized and be counted as agents of air quality policy. The proposed data-driven approach which combine big data analysis and MCDM methods could lead researchers and public administrators to transfer gender into the development of air quality management strategies with lower cost by using big data. The findings can offer policy makers fresh insights from which they can formulate policies that enhance gender involvement and which cater specifically to females' needs, many of which, historically, have been ignored in this context.

英文關鍵詞：Air Pollution, Environmental attitudes, Gender Difference, Social Media , Multiple Criteria Decision Making(MCDM), Structural Equation Modelling (SEM), Policy Instruments

科技部補助專題研究計畫成果報告

（□期中進度報告/■期末報告）

以巨量資料分析及多準則決策法萃取我國女性對 PM2.5 空氣品質之知覺、態度與政策偏好

Females' Awareness, Attitudes, and Policy Preferences Toward PM2.5 Air Pollutants in Taiwan: An Integrated Big Data Analysis and Multiple Criteria Decision-Making Approach

計畫類別：■個別型計畫　□整合型計畫
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執行機構及系所：財團法人國家實驗研究院國家高速網路與計算中心
計畫主持人：楊嘉麗博士
共同主持人：許菁君助理教授/國立宜蘭大學應用經濟與管理學系
蔡惠峰研究員/財團法人國家實驗研究院國家高速網路與計算中心

本計畫除繳交成果報告外，另含下列出國報告，共 3 份：
□執行國際合作與移地研究心得報告
■出席國際學術會議心得報告
□出國參訪及考察心得報告

中　華　民　國　110　年　10　月　10　日

Females' Awareness, Attitudes, and Policy Preferences Toward PM2.5 Air Pollutants in Taiwan: An Integrated Big Data Analysis and Multiple Criteria Decision-Making Approach

Abstract:

Air pollution, which is the most pressing environmental problem in developing countries, is particularly bad in Taiwan, a country facing tough choices in balancing environmental protection with economic growth. With growing scientific evidence showing the harmful impact of air pollution on the environment and individuals' health in modern societies, public concern about air pollution has become a central focus of the development of air pollution prevention policy. Past research has shown that women are more aware of everyday hazards that often motivate social action because the significant differences exist in terms of knowledge, awareness, and attitudes towards air pollution than men. Despite close links between air pollution and gender, there is a lack of studies on whether gender differences exist for general environmental perceptions and attitudes. A gender analysis of perceived environmental vulnerability is necessary. Seeing air pollution through women's eyes reflects women' specific needs and interest in air pollution. Thus, this research is for developing a research agenda on gender and air quality awareness, attitudes, and policy preferences from the perspective of gender difference in Taiwan. At first, this study introduces the research topic map to analyze the trends regarding to air pollution and gender difference studies. The Microsoft Academic Graph database is used to derive general publication as well as citation trends, evolution of research areas, and the relations between research areas being related to air pollution. Secondly, we construct a theoretical model by an integration of social media mining into a value-belief-norm (VBN) model of public concerns about air pollution. We propose a hybrid method integrating text mining, topic modeling, hierarchical cluster analysis and the partial least squares structural equation modelling (PLS-SEM). Third, we future explore the factors influencing females' attitudes toward air pollution by using GIS or rough set methods. Fourth, appropriate environmental education policy tools are defined to enhance female's attitude toward air pollution. A hybrid multi-criteria decision-making (MCDM) model, the DEMATEL Based Analytic Network Process integrated with the Modified Vikor (DANP-MV) is used. The results of this research project explore that females' knowledge should be used and be counted as agents of air quality policy. The proposed data-driven approach, which combines big data analysis and MCDM methods, could lead researchers and public administrators to transfer gender into the development of air quality management strategies with lower cost by using big data. The findings can offer policy makers fresh insights from which they can formulate policies that enhance gender involvement and which cater specifically to females' needs, many of which, historically, have been ignored in this context.

Keywords: Air Pollution, Environmental attitudes, Gender Difference, Social Media , Multiple Criteria Decision Making(MCDM), Structural Equation Modelling (SEM), Policy Instruments.

I. Introduction

Air pollution is currently one of the most pressing environmental concerns in developing countries, especially in Taiwan. The increasingly heavy demand for air quality management has led analysts to examine the source of air quality and its affects. Numerous studies have reported associations between air quality and local agriculture, health, economic factors, and so on [1]. There is a growing epidemiologic evidence of differing associations between air pollution and respiratory health for men and women [1, 2]. Women are also more aware of environmental hazards that often motivate social action than men because significant differences exist between the genders in terms of knowledge, awareness, and attitudes [3, 4]. Considerations of gender differences in terms of air-quality issues provide new insights for researchers and policy makers.

Despite the close links exist between air quality and gender, the potential relationship between air pollution and gender-related differences has not been studied yet. Some studies have integrated gender into environmental disaster research as a demographic variable. Very few works have tried to integrate gender relations as a factor and engage women as equal partners in air quality management policy. Current environmental policy makers, in governmental agencies and non-profit organizations, less consider that gender is a part of disaster strategies. Although women are identified as highly vulnerable yet crucial keys to prevention. Gender is less evidently a part of current air-quality policy in practical, although women have been identified as vulnerable and crucial players in leading their neighbourhoods towards a safer environment. A successful environment disaster policy requires a high level of awareness from citizens, positive attitudes, and public support for the relevant policies. Such policy requirements are in citizens' interest, usually with adjustments by gender differentials between men and women. Evidence suggests that existing environmental projects fail to promote women's interests. Gender is a central organizing principle in social life. The lack of recognition of females' awareness, attitudes, and policy preferences in environmental disasters has inhibited females' ability to campaign for safer air in their communities.

Seeing air-quality issues from women's viewpoint raises recent issues for researchers and policy planners, identifies critical system gaps, and brings gender to the forefront of development and air-quality prevention work. Thus, this research is for developing a local research agenda on gender and air quality awareness, attitudes, and policy preferences from the perspective of females. The research methologies comprises big data analysis and multiple criteria decision-making (MCDM) methods. The big data analysis methods include text mining, partial least squares structural equation modeling (PLS-SEM), associate rule mining (ARM), and rough set. The MCDM methods include the decision-making trial and evaluation laboratory (DEMATEL) technique, DEMATEL-based analytic network process (DANP), and Vikor. At the first, this work analyzes research papers that have been published

in Microsoft Academic Graph database and analyzes air quality and gender systematically from formal researches. Second, this research identifies Taiwan people' major concerns about air quality from crowdsourcing social media. We construct a theoretical model by an integration of social media mining into a value-belief-norm (VBN) model of public concerns about air pollution. Third, we future explore the factors influencing females' attitudes toward air pollution by using GIS or rough set methods based on the results of the first and second stage. Fourth, appropriate environmental education policy tools is defined to enhance female's attitude toward air pollution. A hybrid multi-criteria decision-making (MCDM) model, the DEMATEL Based Analytic Network Process integrated with the Modified Vikor (DANP-MV) is used (Figure 1). The results of this research is to explore women's major concerns and the determinants of air quality in Taiwan. The research results is to the development of central gender air quality management strategies and suggest appropriate ways to evaluate and select air quality policy instruments for policymakers.

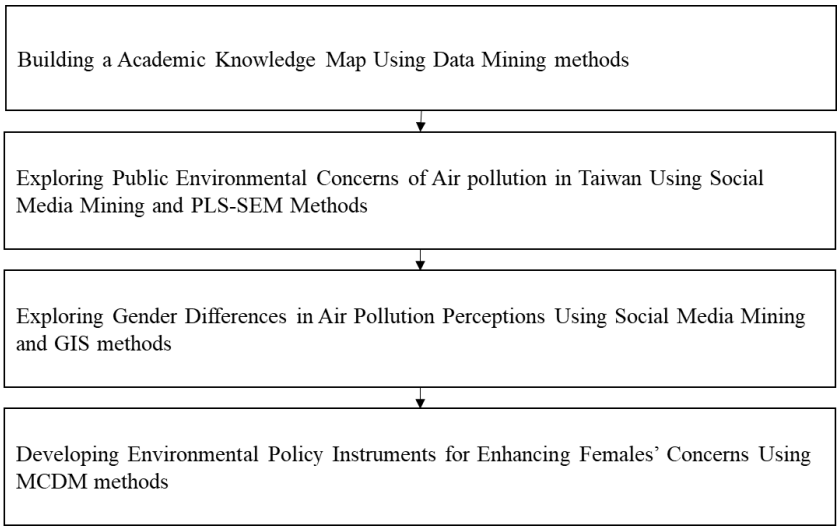


Fig 1 Research Flow

II. Literature Review

This project is to explore the awareness, attitudes, and policy preferences of females relating to air quality in Taiwan. Regarding the research problems, related literatures are reviewed and summarized below.

2.1 Environmental concern and Gender

Environmental concern is the degree to which people are aware of environmental problems and support efforts to solve these problems and/or indicate a willingness to contribute solutions to such problems [5]. Environmental concern could be the beliefs, affects, and behavioral intentions a person holds regarding activities or issues related to the environment [6]. There is wider recognition that

environmental concerns are the key drivers of the intention to change the environment—that is, to engage in pro-environmental behavior [7]. Previous studies have used the theories of reasoned action [8] and planned behavior [9], the norm-activation model [10], and the value-belief-norm theory [11] to explain pro-environmental behavior [12]. The value-belief-norm theory was first established by Stern et al. [13] to explain the influence of human values on behavior in an environmentalist context. According to the value-belief-norm theory, people's attitudes about environmental issues are determined by the value that they place on themselves (egoistic value), other people (social-altruistic value), and plants and animals (biospheric values) [11].

Studies have found that there is an association between environmental concern and gender. For example, Xiao and McCright used the institutional theory to support the hypothesis that women tend to have modestly stronger pro-environmental values, beliefs, and attitudes than men [14]. Combining insights from gender socialization theory and the risk analysis literature, women tend to have less trust and confidence in key social institutions such as government and science than men, which increases their concern for the environment. Women are shown to have higher levels of environmental concern than men, as are individuals with higher levels of education. That is, though higher levels of education are positively associated with perceived environmental risks among liberals, the inverse tends to be true among those with extremely conservative views [15].

2.2 Public Perceptions of Air Pollution and Gender

Air pollution is a major global problem that threatens human life and health as well as the environment [16]. Public concern and support are one of the most important resources of social movements [13]. There is a consensus in the literature regarding the strong linkages between public perceptions of air pollution and emotional and behavioral responses to air pollution [12, 17]. Unlike professional air pollution evaluations based on scientific data, public perceptions of air pollution appear to be heterogeneous and complicated by various influential factors and mechanisms. For example, several studies have been conducted to assess correlations of individual difference to concerns regarding air pollution from psychological and sociological perspectives. The researchers argued that the individual factors such as knowledge [17], race [18], and gender [19] can moderate the influence of individual perceptions of air pollution. ender appears to be one of the primary characteristics related to physical and social dimensions. The research shows that women have a higher level of awareness about everyday hazards, such as air pollution, which often motivates social action [20-22]. Garcia-Vargas et al. [22] found that women constitute the population most vulnerable to climate change and climate variability and women have important knowledge and skills for orienting the adaptation processes. Although gender is a central organizing principle in social life, gender issues are rarely examined by environment disaster scholars or practitioners. Researchers draw attention to critical limitations and occlusions concerning gender minorities in environment disaster risk reduction policy, which may be a critical focus for future collaborative and applied research [23].

2.3 Social Media and Air Quality

social media are the set of internet-based applications which are built upon the concepts and technology of Web 2.0; social media enables the generation and exchange of content generated by users [24]. Nowadays, social media platforms are typically applied in expressing opinions or viewpoints regarding social events, news, etc., everywhere, with no limitation of time. Future prediction is the great wish of mankind [25]. Social media mining refers to the process of characterizing, analyzing, and deriving important patterns from data retrieved from social media, which are the result of social interaction [24]. Social media mining is a multidisciplinary domain, which includes techniques from computer science, data engineering, social science, and mathematics [5]. The exploration of social media by the above-mentioned techniques helps us understand the mutual interactions of users [24]. Further, interesting patterns, information diffusion, influence relationships, effective and efficient recommendations, as well as novel social behavior can be explored on social media sites [24].

Because air pollution is a serious environmental problem in many developing countries, obtaining timely and accurate information is an important first step toward control of air pollution. Traditionally, researchers have used questionnaire surveys and interviews to collect data on perceived air quality and people's displeasure with air pollution [26-28]. Recent studies have demonstrated the application of social media for monitoring air quality fluctuation, as well as related public attitudes and responses [29, 30]. For example, Wang et al. [29] found that social media contains rich detail regarding perceptions, behaviors, and self-reported health effects, which can augment existing air pollution surveillance data, especially the sources of perceptions and health-related data. Hswen et al. [31] proposed that social media may offer a supplemental source of data, and conducted a study in which they used data from Twitter to validate data from established air pollution monitoring stations in a densely populated urban area in London, England .

2.4 Air pollution in Taiwan

Taiwan is facing this problem in the course of seeking equilibrium between environmental protection and economic growth. Some studies have explored the connection between air pollution and disease in Taiwan. For example, Tseng et al. [32] investigated the effects of prevalence changes in tobacco smoking and particulate matter (PM) 2.5 levels on lung cancer by examining 371,084 lung cancer patients in Taiwan. According to the work by Tseng et al. [32], more than 50% of patients with lung cancer had never smoked, and that PM2.5 level changes can affect adenocarcinoma lung cancer incidence and patient survival. Lee et al. [33] investigated the influence of ambient air pollution on Parkinson's disease by reviewing data of 11,117 patients' from the Taiwanese National Health Insurance Research Database and selected 44,468 age- and gender-matched population controls from the longitudinal health insurance database. They found that ambient air pollution

exposure, especially from traffic-related pollutants such as nitrogen oxides and carbon monoxide, increases the risk of Parkinson's disease. Chiu et al. investigated the relationship between air pollution and lung cancer in women, and found that women who lived in areas with the highest pollution exposure index were at a statistically significant increased risk of developing lung cancer compared to those living in areas with the lowest air pollution exposure index [34].

Because of rising cardiovascular and lung disease in Taiwan, air pollution has attracted great attention from Taiwanese citizens. Reflecting the importance of air quality, the Taiwanese government implemented a strategic plan in 2016 to address air pollution control. Furthermore, the pursuit of better air quality has urged policy makers to initiate monitoring of air pollution: the government built more than 77 air quality monitoring stations in the country as of 2020, according to the Taiwan Air Quality Monitoring Network (TAQMN) [35].

III. Methodology

The object of this study is to explore females' awareness, attitudes, and policy preferences in relation to air pollution in Taiwan. To effectively accumulate knowledge from large databases, the big data analysis, MCDM and PLS-SEM methods can be merged.

3.1 Text Mining and Topic modelling technique

Text-mining has become a popular topic across a wide range of fields such as public health, disaster management, and environmental management [36]. Text-mining techniques are used to extract knowledge to derive meaningful structural information from irregular data patterns or unstructured forms of data to provide meaningful information patterns in the shortest time period [37]. Thus, during the past years, text-mining methods have widely been adopted in numerous research fields such as computational linguistics, information retrieval, data mining, etc. Topic modelling, a machine learning technique in the field of data-mining, is the most popular analytic method for the text-mining of social media. Topic modelling is the process of learning, recognizing, and extracting high-level semantic topics across a corpus of unstructured text. The technique is used to clarify the structure of a group of documents by estimating the words distribution that constitute a topic based on the premise that each group of documents which constitutes a corpus belongs to a specific topic [38]. Amongst the techniques, LDA is a generative probabilistic model of a corpus, is an unsupervised machine learning technique which aims to identify the information in latent topics in a collection of large documents. The basic idea of LDA is that the documents are represented as random mixtures over latent topics, where a topic is characterized by a distribution over words. LDA treats each document as a vector of words. Each document is represented as a probability distribution over some topics, while each topic is represented as a probability distribution over a number of words.

3.2 PLS-SEM

The SEM methods are widespread in marketing and management research, while analyzing the cause–effect relations between latent constructs. The PLS-SEM is one of the SEM methods which aims to maximize the explained variance of the dependent latent construct [39]. Like other SEM techniques (e.g., the linear structural relations, the LISREL), the PLS approach allows researchers to simultaneously assess the parameters of the measurement model and the coefficients of the structural path. The covariance-based SEM techniques, such as the LISREL and the EQS, use a maximum likelihood function to obtain estimators in models. Instead, the PLS-SEM uses a least-squares estimation procedure. PLS-SEM avoids many restrictive assumptions that underlie the covariance-based SEM techniques, such as multivariate normality and large sample size. PLS-SEM analyzes various relationships among several factors, i.e., latent and observed variables. A latent variable is an invisible concept for a target analysis. An observed variable is an observable item from a target analysis and is used to estimate a latent variable. These variables have relationships, such as causal and co-occurrence relationships. PLS-SEM was used as the research method in this work because the sample size may be non-normally distributed due to the nature of the data being retrieved from social media websites.

3.3 Rough Set Theory

Rough Set (RS) theory, originally proposed by Pawlak in the early 1980s [40], is a mathematical tool to deal with vagueness and uncertainty. RS is one of the fundamental to artificial intelligence(AI). RS is especially used in the areas of decision analysis, expert systems, machine learning, decision support systems, inductive reasoning, and pattern recognition. The basic concept of RS theory makes use of the lower and upper approximation of a set. The main advantage of RS theory is that it does not need any preliminary or additional information about data, such as probability distribution in statistics, basic probability assignment in the Dempster-Shafer theory, or grade of membership or the value of possibility in fuzzy set theory [41]. Thus, RS theory has been applied in various applications including extraction of decision rules from data, especially in the presence of uncertainty and vagueness [42].

3.4 DEMATEL Method

The DEMATEL method was originated by the Geneva Research Centre of the Battelle Memorial Institute [43]. The DEMATEL identifies the interrelations between factors to build a network relations map (NRM) which can convert complex systems into a clear causal structure. The methodology of DEMATEL can confirm interdependence among factors and identify the relationships that reflect characteristics within an essential systemic and developmental trend. The DEMATEL technique has been successfully applied in many situations, such as identifying key

successful factors in emergency management [44], risk control assessment [45], and risk factors for IT outsourcing [46]. As this research aims to identify the causation and influencing strengths of the consideration factors, we employ the quantitative DEMATEL method.

3.5 The DANP

The DANP is an analytic method that integrates DEMATEL and the ANP proposed by Prof. Gwo-Hshiung Tzeng [47, 48]. Traditionally, the ANP requires a pre-defined structure of the decision-making problem. Thus, decision makers may introduce the structure based on the IRM being derived by DEMATEL (refer to [49] for a typical example) or by other analytic methods. However, such work usually requires two or more iterations of collecting questionnaires, which wastes time and can be complicated. Respondents to the first iteration questionnaire may refuse to provide opinions for the second iteration questionnaire, which usually causes problems of inconsistency. Moreover, due to the complicated IRM derived by DEMATEL, a threshold value is usually required to screen the most important influence relationships inside the TRM. However, such screening usually filters out a lot of connections in the TRM. To overcome such limitations, the DANP feeds the IRM by DEMATEL into the ANP.

3.6 VIKOR Method

The VIKOR method was originated by the Opricovic [50] . The VIKOR method is used to integrate performance gaps from criteria to dimensions of complex systems. The VIKOR determines the compromise ranking list and compromise solution, and the weight stability intervals for the preferred stability of the compromise solution can be obtained from the initial weights given by the AHP or ANP in the traditional method [51, 52]. This method focuses on ranking and selection from a set of alternatives in cases of conflicting criteria. It introduces a multi-criteria ranking index based on the particular measure of “closeness” to the “ideal” solution [50]. This study use the VIKOR method to obtain the aspiration level and learn how to select optimal policy instruments to make tailored air quality policy based on Taiwan women’s needs.

IV. Research Results

Based on the proposed research flow, we publish 2 international journal and 8 conference paper as following (Figure 2).

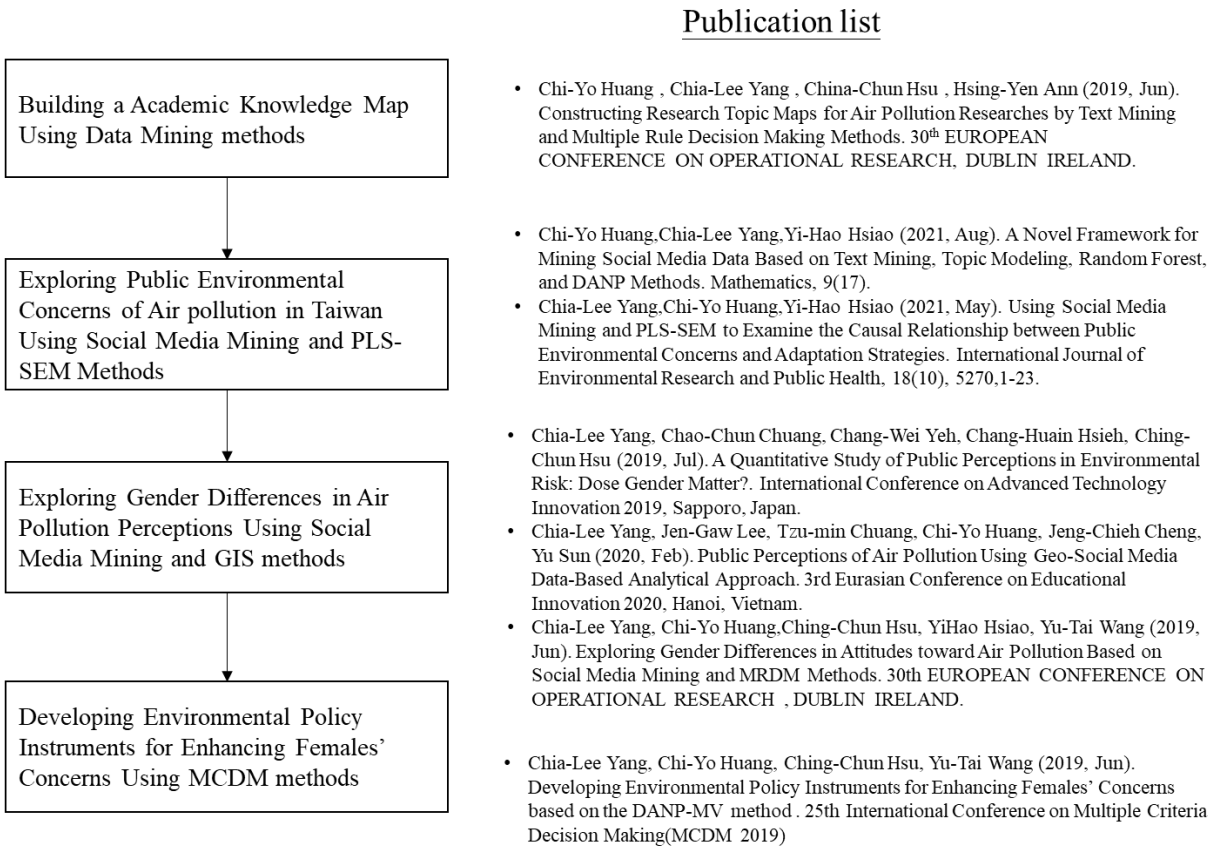


Fig 2 Research publications

4.1 Building an Academic Knowledge Map Using Data Mining methods

We analyze online research papers and examine the correlation between air pollution and gender differentiation systematically from formal researches by using big data analytics. The Microsoft Academic Graph (MAG) database is used to derive general publication as well as citation trends, evolution of research areas, and the relations between research areas being related to air pollution. 165,246 academic papers and patents have been collected from MAG to provide essential air pollution research issues and future trends. The 7178 academic papers have full abstract. The text-mining package, TextAnalyst 2.1, is used to extract the keywords. We analyze text data in R. data. LDA topic modeling is used to analyse terms and topics from the entire dataset and to produce a topic model. 25 topics were identifiable from the LDA output (Table 1). The relationship of the research topics map were also found from Association Rule Mining and DEMATEL (Fig 3).

Table1. Result of air pollution research paper topics

		1873-2018			2002-2018		
		Mount	Rank	Growth rate	Mount	Rank	Growth rate
1	Air Quality System	180	23	8%	140	20	15%
2	Power Plants	224	20	19%	115	23	47%
3	Traffic Air Pollution	256	16	12%	141	18	36%
4	Building Indoor Air	277	12	11%	192	13	9%
5	House Air	368	6	28%	239	6	14%
6	Diseases Risk	533	1	43%	166	16	39%
7	Air Quality Monitor	239	18	16%	189	15	32%
8	Energy	333	7	20%	266	5	16%
9	Indoor Air QC	267	14	-1%	224	11	24%
10	Meteorological	182	22	45%	115	23	73%
11	Air Particles	470	2	16%	415	1	-3%
12	Wind	381	3	-2%	306	3	14%
13	Pollution Emissions	252	17	25%	156	17	30%
14	Health Effect	147	24	13%	117	21	51%
15	Pollution Particulates	261	15	25%	141	18	19%
16	Organic Compounds	294	10	23%	233	8	22%
17	Urban Air	381	3	-11%	353	2	17%
18	PM	272	13	3%	201	12	38%
19	Air Pollution Model	325	9	3%	238	7	9%
20	Monitoring Data	290	11	9%	227	9	34%
21	Climate	333	7	1%	296	4	17%
22	Standards	127	25	6%	100	25	41%
23	Pollution Act	370	5	29%	226	10	14%
24	Air Quality Management	186	21	11%	117	21	14%
25	Air Quality Index	230	19	10%	190	14	14%
		7178			**5103**		

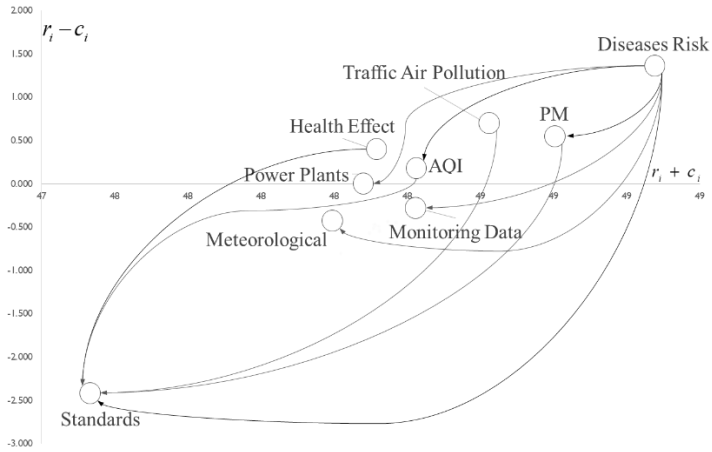
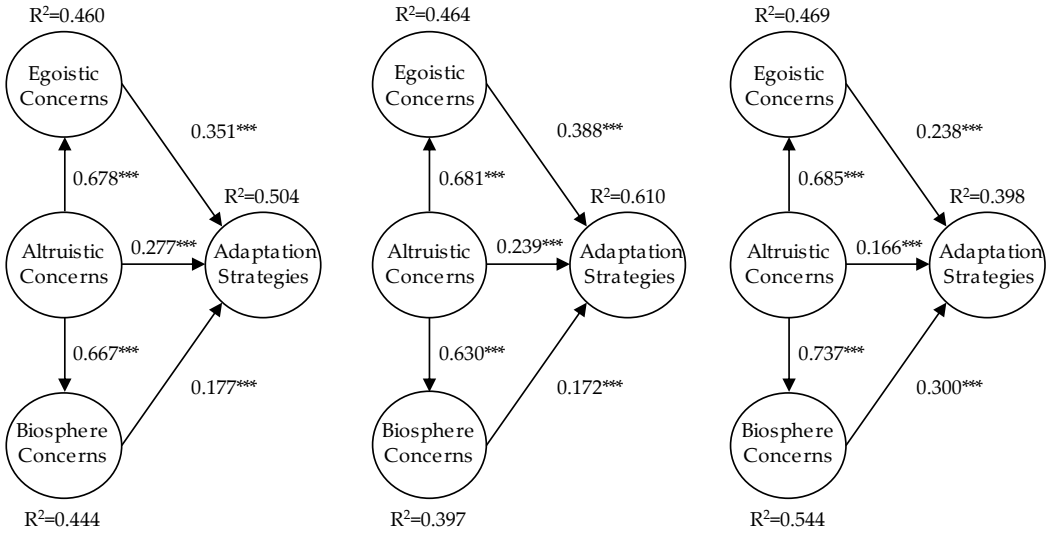


Fig 3. The casual relationship of the research topic map

4.2 Exploring Public Environmental Concerns of Air pollution in Taiwan Using Social Media Mining and PLS-SEM Methods

This work uses the web crawler, text-mining methods ,and topic analysis to identify the major concerns and needs for air quality in Taiwan. Dcard is a Taiwanese social network that focuses specifically on college students and offering users a unique “friending” experience. The articles have been collected from Dcard to provide essential air pollution/PM2.5 /air quality issues. The text-mining techniques were used to identify the keyword list. To discover topics of air pollution on social media of Dcard, we used Latent Dirichlet Allocation (LDA) to analyze terms and topics from the

entire dataset and to produce a topic model. To verify the correlation relationships of topics, the relationships are confirmed as the path model by the PLS-SEM approach based on the results of topic model by LDA(Fig 4).



(a)) both genders (b) men, (c) women.

Notes: *: p<0.050; **: p<0.010; ***: p<0.001

Figure 4. Path analysis results for environmental concerns by gender difference

4.3 Exploring Gender Differences in Air Pollution Perceptions Using Social Media Mining and GIS methods

We identify the gender differences regarding to air pollution based on text mining, topic modelling, and multiple rule decision-making methods comprising the Rough Set (SA), GIS and the Decision-making Trial and Evaluation Laboratory (DEMATEL). According to the result of DEMATEL in Figure 5, the topics of "coal burring", " public vote" and "political" are the cause factors which influence on people's "sentiment," and the "sentiment" influence on "my lifestyle". According to the result of RS in Table 2, we find that if females concern of "Coal burning" and "Politics," but do not concern of "My Lifestyle" or "Public Vote", then they have negative sentiment. If female concerns of coal burning and Nuclear energy , but do not concern of "Politics" and "Regional Pollution" , then their sentiment are positive.

Future, we exam the gender and regional pollution effect based on geo-tagged social media data. The geographic content of social media provides an unparalleled view of the complex social networking and cultural dynamics within a society, and captures the temporal evolution of the human landscape. We use the volume of social media posts as data source to build the public perceptions

of air pollution density map as figure 7 and 8.

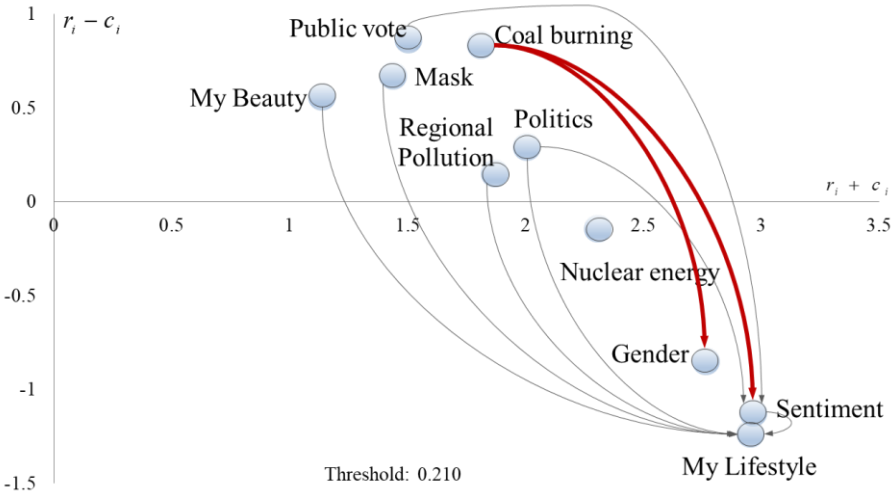


Fig 5. Causal relationship of air pollution topics and gender

Table 2. Rough set results of air pollution sentiment decision table

Rule	Antecedent	Consequent (Sentiment)	Strength rate (%)
1	Female & Coal burning =1 &Politics=1 & My Lifestyle=0 &Public vote=0	Negative	15
2	Female & Coal burning =1 &Nuclear energy=1 &Politics=0 & Public vote=0	Positive	36
3	Female & Coal burning =1 &Nuclear energy=1 & Politics=0 & Regional Pollution=0	Positive	55

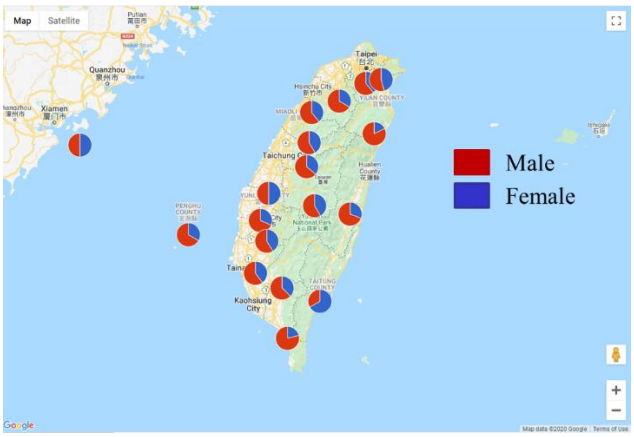


Fig 7 Gender difference on social media posts of air pollution

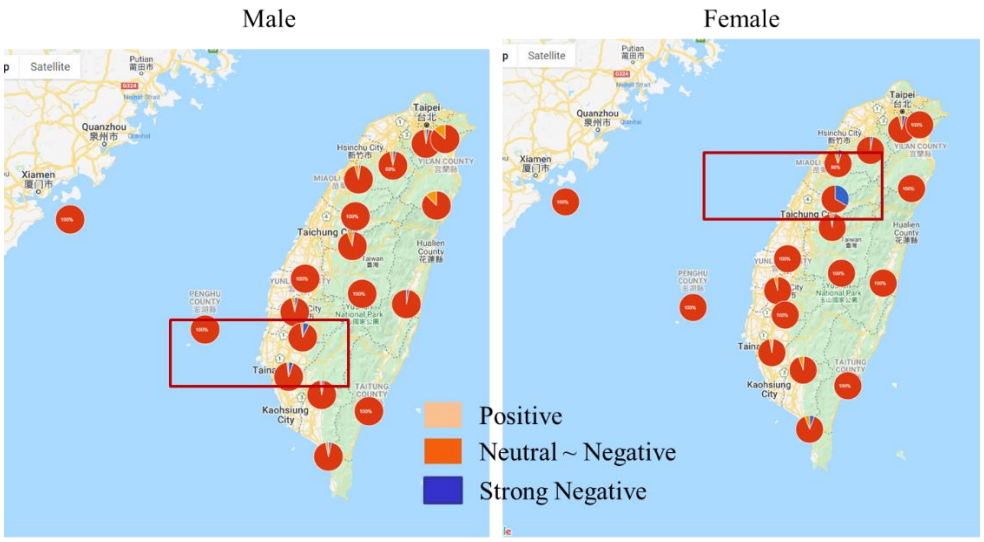


Fig 8 Gender difference of positive/negative emotion on social media posts of air pollution

4.4 Developing Environmental Policy Instruments for Enhancing Females' Concerns Using MCDM methods

We find the female's concerns and the improving strategies of air pollution. A hybrid multi-criteria decision-making (MCDM) model is used to address the influence relationships of factors that combines Decision Making Trial and Evaluation Laboratory (DEMATEL), and DEMATEL-based Analytical Network Process (DANP), and the Vlse Kriterijumska Optimizacija Kompromisno Resenje (VIKOR). We invited female and air quality experts heavily involved in the process of air quality research and policy to a focus-group meeting. We construct research frameworks based on the Theory of Planned Behavior. The 28 factors in 9 aspects according to the opinions of experts. They were asked to identify the most important factors form big data mining results regarding air quality policy and to group similar factors into categories. Then, a gender-responsive air quality policy evaluation model was constructed with weightings and relationships evaluated by adopting MCDM methods. The selected experts were required to have over five years' experience working with females in air quality, and the sample size needed to satisfy the requirement of the MCDM methods. The results shows in table 3.

Table 3. Results of DNP and Vikor

	ANP Weights	Performance Gaps to the aspiration (VIKOR)				
		A. Command and control Regulation	B. Direct provision	C. Engaging the public	D. Using Markets	E. Creating markets
Attitude (ATT)	0.126	0.126	0.101	0.025	0.093	0.084
Injunctive Norm(IN)	0.093	0.046	0.066	0.053	0.066	0.093
Descriptive Norm(DN)	0.087	0.064	0.087	0.029	0.047	0.076
Perceived Behavior Control (PBC)	0.095	0.055	0.095	0.040	0.079	0.079
Awareness of Consequences(AC)	0.113	0.113	0.113	0.075	0.100	0.113
Emotion(EM)	0.127	0.119	0.127	0.119	0.103	0.087
Risk Perception(RP)	0.112	0.070	0.077	0.105	0.112	0.112
Behavior Intention(BI)	0.125	0.071	0.080	0.125	0.098	0.098
Behavior(B)	0.122	0.071	0.071	0.071	0.122	0.071
Total gap	1	**0.737**	**0.818**	**0.642**	**0.820**	**0.813**
Gap		0.126	0.127	0.125	0.122	0.113
Qj (v=0.5)		0.738	0.994	0.422	0.828	0.480
		3		1		2

V. Discussion

5.1 The air pollution topics of most concern for Taiwanese

According to the results of our analyses, the policy ambiguity, wind power generation policy, coal-fired power generation, refuse combustion, and power generation are the air pollution topics of most concern for Taiwanes . These results may be attributed to the Taiwan's energy dilemma between anti-nuclear energy and anti-air pollution from fossil fuels energy. According to the Energy Statistics of Taiwan [53], about 93% of Taiwanese energy consumptions were imported fossil fuels. Taiwan has been facing an energy policy dilemma because of the desirability of multiple goals: achieving a nuclear-free homeland, reducing air pollution from fossil fuels, and restricting the receiving capacity of liquefied natural gas terminals. Some people are against nuclear power because of the public anxiety from the Japan Fukushima Daiichi nuclear disaster in 2011 and problems with storing nuclear waste. Anti-nuclear activists advocate turning Taiwan into a nuclear-free country by 2025. Some people are against the coal-fired power generation plants because of the rise in air pollution causing 6,000 air-pollution related deaths per year in Taiwan [54]. Anti-air pollution activists promote the view that nuclear energy might provide an alternative form of power generation to decrease the use of coal-fired thermal power. The debates regarding energy policy have led to political and legal limbo regarding air pollution in the 2018 Taiwan referendum. Our research results are in line with the realistic social situation.

5.2 Gender difference on air pollution concerns

Besides the effects of different environmental concern on the adaptation strategies, the research further emphasized that gender is a significant moderating variable in the relationship of egoistic concerns, altruistic concerns, and adaptation strategies. However, our results differ from those of previous studies that indicated that women tend to show higher levels of concern about environmental

problems than men do [55, 56]. One explanation is based on the system justification perspective, which suggests that people's attitudes of desire not only depend on themselves but also on the overarching social structure to which they are obligated. In this study, men chronically engage in more system justification than women do, which partially explains men's greater willingness to acknowledge ecological problems and risks and to engage in actions that are beneficial for the environment [57]. Another explanation may be related to gender differences in social media use. Women are more avid users of social media [58]. In our research, all topics reflecting egoistic and altruistic motives are brought up by men more than women. In the education context, this implies that educators can emphasize egoistic and altruistic concern topics in promoting an adaption strategy to air pollution to increase female citizens' concern. the gender differences exist in the relationship of air pollution concerns and actions intention. The results may be explained by the social construct expectation [59]. Men are socialized to be protectors of and providers for the family, and may portray environmental pollution as a necessary tradeoff for growth. Men are more likely to link egoistic and altruistic concerns to actions. In contrast, women are more concerned about biosphere environmental problems because women are socialized to be family nurturers and caregivers for children and have greater social responsibility and empathy towards others. Women are more likely to link biosphere concerns to actions [60]. In addition, our study shows that the priorities of men and women regarding which environmental concerns were most important are different.

VI. **Conclusion and contributions**

In addressing the role of gender in the context of the environment, it is important to recognize that women and men are not homogenous groups. Where women and men live, their age, social class, ethnicity, religion, sexual orientation, and other variables interact in shaping the links between gender and the environment. In this research, we indicate that men and women have different attitudes toward air quality. In this project, we analyze online research papers that have been published and analyze air quality and gender systematically from formal researches at the grassroots level. We define females' major concerns of air pollutants in Taiwan from social media forums at the individual level. Furthermore, we analyze the factors that influence females' attitudes toward air quality in Taiwan. We explore the key determinants that influence females' awareness of, and attitudes toward, air pollutants. We also integrate females' attitudes into air quality policy instruments in Taiwan. The analysis of females' attitude toward air pollutants problems are inherently complex involving difficult tradeoffs. The analytic framework is used to select optimal air quality policy instruments to effectively integrate females' needs in relation to air quality policy.

Women provide a livelihood for their families and simultaneously manage the environment. However, due to gender power relations, females' knowledge is often overlooked and they are not counted as agents of change. The promotion of female's awareness and attitudes into policy is a key for gender equality, and it is receiving a growing attention in government's agendas. However, gender

gaps are still a wide phenomenon. While gender gaps in environment disaster is decreasing remarkably over time. The rising of feminist theory and vulnerability theory provide an alternative approach linking social needs and gender equality to environmental disaster management. This research extends the existing air pollutants research by applying the social science viewpoint and brings gender centrally into consideration of air pollutants policy. The findings can offer policy makers fresh insights from which they can formulate policies that enhance gender involvement and which cater specifically to females' needs, many of which, historically, have been ignored in this context. The findings can offer policy makers fresh insights from which they can formulate policies that enhance gender involvement and which cater specifically to females' needs, many of which, historically, have been ignored in this context. This research can provide new opportunities for women and men to have equal access to participation and leadership.

Besides, this paper proposes a combination of two kinds of research models: one based on big data analysis and the other on MCDM expert modelling. We demonstrate that MCDM expert models refined with big data analysis and align with the accuracy of data mining models. We provide a causal relationship between females' attitudes and selecting optimal policies. The proposed data-driven approach, which combines big data analysis and MCDM methods, could lead researchers and public administrators to transfer gender into the development of air quality management strategies with lower cost by using big data. This project provides researchers and policy makers with a research pipeline for a social media data analysis.

VII. Suggestions

Without strong decision-making power in government, women's desires and skills are often not recognized or used. Gender is a central organizing principle in social life, and hence in disaster-affected communities, yet gender issues are rarely examined by environment scholars or practitioners. Researchers draw attention to critical limitations and occlusions concerning gender minorities in disaster risk reduction policy and these gaps should be a critical focus for future collaborative and applied research [61]. Our study suggests a need to further review international research papers on increasing female awareness of air quality, and ensure that these results are effectively supported theoretically. Although the use of big data analysis approaches to address women' specific interests, vulnerabilities, and needs might find favour with environment policy makers, how to use the results of the data still needs more efforts in the future.

Appendix

The publications of this project is as following.

Type	Publications	note
Journal papers	**1.** Chia-Lee Yang, Chi-Yo Huang, Yi-Hao Hsiao (2021, May). Using Social Media Mining and PLS-SEM to Examine the Causal Relationship between Public Environmental Concerns and Adaptation Strategies. *International Journal of Environmental Research and Public Health*, 18(10), 5270,1-23. **SSCI, JCR Q1 (Public, Environmental & Occupational Health) / CiteScore Q2 (Public Health, Environmental and Occupational Health). IF 3.390 (2020) ; 5-Year Impact Factor: 3.789 (2020)** 2. Chi-Yo Huang, Chia-Lee Yang, Yi-Hao Hsiao (2021, Aug). A Novel Framework for Mining Social Media Data Based on Text Mining, Topic Modeling, Random Forest, and DANP Methods. *Mathematics*, 9(17). **SCI, JCR Q1 (Mathematics), CiteScore Q1 (General Mathematics), IF 2.258 (2020) ; 5-Year Impact Factor: 2.165.**	JCR Q1 journal，IF >2
Conference paper	1. Chia-Lee Yang*, Chi-Yo Huang, Ching-Chun Hsu, Yi-Hao Hsiao, Yu-Tai Wang. Exploring Gender Differences in Attitudes toward Air Pollution Based on Social Media Mining and MRDM Methods. 30th EUROPEAN CONFERENCE ON OPERATIONAL RESEARCH (EURO 2019). Dublin, Ireland, June 23-26, 2019. 2. Chia-Lee Yang*, Chi-Yo Huang, Ching-Chun Hsu, Yu-Tai Wang. Developing Environmental Policy Instruments for Enhancing Females' Concerns based on the DANP-MV method", 25th International Conference on Multiple Criteria Decision Making (MCDM 2019). Istanbul, Turkey, June 16-21, 2019. 3. Chi-Yo Huang, Chia-Lee Yang*, China-Chun Hsu, Hsing-Yen Ann. Building a Research Topic Map toward Air Pollution By Data Mining Approach. 30th EUROPEAN CONFERENCE ON OPERATIONAL RESEARCH (EURO 2019). Dublin, Ireland, June 23-26, 2019. **4.** Chia-Lee Yang*, Chao-Chun Chuang, Chang-Wei Yeh, Chang-Huain Hsieh, Ching-Chun Hsu. A Quantitative Study of Public Perceptions in Environmental Risk: Dose Gender Matter? International Conference on Advanced Technology Innovation 2019(ICATI 2019). Sapporo, Japan, July 15-18, 2019. **Best paper award** **5.** Chia-Lee Yang*, Jen-Gaw Lee, Tzu-min Chuang, Chi-Yo Huang, Jeng-Chieh Cheng, Yu Sun (2020, Feb). Public Perceptions of Air Pollution Using Geo-Social Media Data-Based Analytical	2 best paper awards

	Approach. 3rd Eurasian Conference on Educational Innovation 2020, Hanoi, Vietnam. **Best paper award** 6. Chia-Lee Yang*, Yi-Lang Tasi, Hsing-Yen Ann, Hong-Ji Wei, Yi-Hua Lin1" Determinants of User's Acceptance and Satisfactions on Cybersecurity Exercise System in Education: An Empirical Study. International Conference on Advanced Technology Innovation 2019(ICATI 2019). Sapporo, Japan, July 15-18, 2019. 7. Yu-Hsin Chen, Ben-Jei Tsuang, Kai-Chen Ku, Yu-Ru Liao, Chia-lee Yang (2020, Oct). Observation of Air Quality Response to COVID-19 in Taiwan. 2020 International Symposium on COVID-19,, Taipei, Taiwan. 8. 張少銘、楊嘉麗*、莊朝鈞、蕭志棋、蕭一豪（2020 年 10 月）。運用開放資料探討新冠肺炎疫情對大眾運輸流量之影響。TANET 2020 台灣網際網路研討會，台北，台灣。	

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日期：108 年 8 月 1 日

計畫編號	MOST－107-2629- M-492-001－MY2		
計畫名稱	以巨量資料分析及多準則決策法萃取我國女性對 PM2.5 空氣品質之知覺、態度與政策偏好		
出國人員姓名	楊嘉麗	服務機構及職稱	財團法人國家實驗研究院國家高速網路與計算中心/正工程師
會議時間	108 年 7 月 15 日至 18 日	會議地點	日本札幌
會議名稱	International Conference on Advanced Technology Innovation 2019(ICATI 2019)		
發表題目	A Quantitative Study of Public Perceptions in Environmental Risk: Dose Gender Matter?		

一、 參加會議經過

108 年 7 月 14 日至 21 日，因執行科技部專題研究計畫: 以巨量資料分析及多準則決策法萃取我國女性對 PM2.5 空氣品質之知覺、態度與政策偏好，將研究計畫部分成果，投稿至 International Conference on Advanced Technology Innovation 2019 並獲通過。本次會議地點於日本札幌，職以第一作者且發表人身分，於本次會議共發表二篇，一篇為口頭論文，另一篇採海報形式發表。

7 月 15 日前往會議報到，7 月 16 日前往發表口頭論文" A Quantitative Study of Public Perceptions in Environmental Risk: Dose Gender Matter?"，發表場次為最佳論文競賽場次，每人 15 分鐘報告 15 分鐘問答，由 5 位評審逐一問答。，7 月 16 日下午則發表論文"Determinants of User's Acceptance and Satisfactions on Cybersecurity Exercise System in Education: An Empirical Study"於海報場次，7 月 17 與 18 日則持續參與其他場次議程。7/19-7/20 接續參加 2019 International Cartographic Conference (ICC 2019)，此為每二年舉行一次之國際地理資訊、地圖等大型國際會議，由於本計畫執行環境態度研究過程，發現與地理資訊高度相關，後續將接續結合地理資訊，因此透過餐與 ICC 2019 會議，找出新的研究方向。7 月 21 日搭機返台，結束本次會議行程。

二、 與會心得

本次參與 ICATI 2019 年國際研討會，主動報名參與最佳論文競賽，以競賽方式檢驗研發成果。主因本研究計畫產出之一部分成果，係以社群媒體資料取代傳統問卷，用以建構結構方程式模型，研究方法上整合自然語言處理、文字探勘、統計與結構方程式多種方法，為標準之跨領域跨學科研究，十分需要各領域學者檢驗，此次透過競賽方式，與資訊工程、統計、管理等學者面對面溝通，對於研究品質提昇極有幫助，十分感謝科技部經費上的支持。

此外，本專題計畫研究成果，已逐一公開發表，包括於 2019 年 6 月發表於全世界多準則決策分析領域最著名研討會「第 25 屆國際多準則決策會議」、歐洲作業研究領域最知名研討會「第三十屆歐洲作業研究國際會議」發表三篇，International Conference on Advanced Technology Innovation 2019 年發表一篇，從中取得 MADM 與 OR 理論與應用獲取寶貴指導與經驗，透過不同類型學術會議，與各地學者當面討論並約定合作研究，快速擴展研究視野與累積成長經驗，對於本研究計畫提升跨領域研究合作能量，極有幫助。

三、 發表論文全文或摘要

論文摘要如下，全文已推薦轉投期刊。

A Quantitative Study of Public Perceptions in Environmental Risk: Dose Gender Matter?

Chia-Lee Yang[1,*], Chao-Chun Chuang[1], Chang-Wei Yeh[1], Chang-Huain Hsieh[1], Ching-Chun Hsu[2]

[1] National Center for High-Performance Computing, National Applied Research Labs, HsinChu 300, Taiwan.

[2] Department of Applied Economics and Management, National I Lan University, I Lan, Taiwan

Received xx mm 201x; received in revised form xx mm 201x; accepted xx mm 201x

Abstract

Research to date has suggested that a close relationship exists between environmental problems and health, but it remains unclear whether gender differences exist for general environmental perceptions and attitudes. A gender analysis of perceived environmental vulnerability is necessary, looking at gender aspects of experiences of environmental degradation. The purpose of this paper is to explore what air-pollution topics are commonly discussed in the public-health sector and whether there are differences between genders and air pollution concerns. Social media streams are the fastest first-hand sources of information generated by public; the content diffused through social media, although noisy, provides an important complement to traditional news media reporting. This research describes a topic modelling framework for discovering air-pollution topics in social media. We first detect sentiment and topic simultaneously from social media text. Then the partial least squares technique of structural equation modelling (PLS-SEM) was used to explore the hypothesized of gender difference toward air pollution concerns. Based on the empirical study results, gender difference is the variable that moderates the relationship between air pollution concerns of personal quality of life and sentiment. Additionally, these results demonstrate that gender consideration is necessary for air pollution policy as well as in environmental sustainability.

Keywords: Air Pollution, Environmental Perceptions, Partial Least Squares technique of Structural Equation Modelling (PLS-SEM), Topic Model, Social Media.

四、 建議: 無

五、 其他:本次論文榮獲最佳論文獎。

BEST PAPER AWARD

This certificate is presented to

Manuscript no.: CL9018
Title: A Quantitative Study of Public Perceptions in Environmental Risk: Dose Gender Matter?
Authors: Chia-Lee Yang, Chao-Chun Chuang, Chang-Wei Yeh, Chang-Huain Hsieh, Ching-Chun Hsu

Awarded to the persons in recognition of the best papers in the International Conference on Advanced Technology Innovation 2019

July 15 ~ July 18, 2019
Sapporo, Hokkaido, Japan

Wen-Hsiang Hsieh

Program Chairman, ICATI2019

科技部補助專題研究計畫出席國際學術會議心得報告

日期：108 年 7 月 1 日

計畫編號	MOST－107-2629- M-492-001－MY2		
計畫名稱	以巨量資料分析及多準則決策法萃取我國女性對 PM2.5 空氣品質之知覺、態度與政策偏好		
出國人員姓名	黃啟祐	服務機構及職稱	國立臺灣師範大學工業教育系/教授
會議時間	108 年 06 月 16 日至 27 日	會議地點	土耳其伊斯坦堡 愛爾蘭都柏林
會議名稱	● 第 5 屆國際多準則決策會議 (MCDM 2019) ● 第三十屆歐洲作業研究國際會議(Euro 2019)		
發表題目	● Developing Effective Air Pollution Improving Strategy of Females' Concerns ● Constructing Research Topic Maps for Air Pollution Researches by Text Mining and Multiple Rule Decision Making Methods		

一、 參加會議經過

為提昇我國國際學術社群與國際多準則決策研究社群暨歐洲作業研究領域先進之交流，並提昇於相關領域之知名度與能見度，瞭解學界研究之進展，作為未來研究方向的參考，與國際知名研究團隊發展未來可能之學術研究合作關係，職將與國家高速網路與計算中心正工程師楊嘉麗博士與國立宜蘭大學許菁君教授近年合作研究之部份成果投稿至第 25 屆國際多準則決策會議 (MCDM 2019)與第三十屆歐洲作業研究國際會議(Euro 2019)，其中，Developing Environmental Policy Instruments for Enhancing Females'Concerns Based On The DANP-MV Method 一文僥倖為 MCDM 2019 委員會接受口頭發表，而 Building a Research Topic Map toward Air Pollution By Data Mining Approach 與 Exploring Gender Differences in Attitudes toward Air Pollution Based on Social Media Mining and MRDM Methods 二文則僥倖由 Euro 2019 委員會接受口頭發表，並由職及楊嘉麗博士個別所執行之科技部計畫預算補助，參加研討會。

二、 與會心得

2019 年 6 月因執行科技部補助專題研究計畫「基於多規則決策分析之後摩爾時代系統晶片設計服務情境分析、服務技術路徑圖推衍、與基於模糊多目標能力集合擴展之研發策略(II)」(106-2221-E-003-019-MY3)，並接受楊嘉麗博士執行科技部專題研究計畫「以巨量資料分析及多準則決策法萃取我國女性對 PM2.5 空氣品質之知覺、態度與政策偏好」補助部份費用， 將研究計畫部份研究結果投稿全世界多準則決策分析領域最著名研討會

「第 25 屆國際多準則決策會議」與歐洲作業研究領域最知名研討會「第三十屆歐洲作業研究國際會議」，基本上算成功圓滿。本次出國，除瞭解多屬性決策分析理論與實務及 OR 之最新進展之外，並與多位學者、專家交換 MADM 與 OR 理論與應用發展的方向及研究合作之可能性，對於未來研究能量提昇極有幫助。

三、 發表論文全文或摘要

1.發表於 MCDM 2019

Developing Effective Air Pollution Improving Strategy of Females' Concerns

Abstract

In the past decade, air pollution has become the world's single biggest environmental health risk and affect all aspects of human life. Air pollution is the particularly pressing for women because women are more susceptible to the negative effects of air pollution than men. Studies show that the differences of environmental attitudes are exits between primarily cisgender men and women in general. Although the increasingly researchers recognize the the two dominant genders think differently on environment issue, very few works have tried to integrate gender relations as a factor and engage women as equal partners in air quality policy. Gender is less evidently a part of current air quality policy in practical, although women have been identified as crucial players in leading their neighborhoods towards a safer environment. The researche questions are what female think differently on air pollution, how to develop of air quality policy instruments? This research aims to find the female's conccens and the improving strategies of air pollution. A hybrid multi-criteria decision-making (MCDM) model is used to address the influence relationships of factors that combines Decision Making Trial and Evaluation Laboratory (DEMATEL), and DEMATEL-based Analytical Network Process (DANP) , and the Vlse Kriterijumska Optimizacija Kompromisno Resenje (VIKOR). An empirical study in Taiwan will be used to verify the effectiveness of the proposed methodology. By exploring the influential interrelationships between concens related to air pollutions, this approach can be used to solve interdependence and feedback problems, allowing for greater satisfaction of the females actual needs of air quality.

Keywords: Air Pollution ,Gender, Hybrid multi-criteria decision-making (MCDM), Decision Making Trial and Evaluation Laboratory (DEMATEL)

2.發表於 EURO 2019

Constructing Research Topic Maps for Air Pollution Researches by Text Mining and Multiple Rule Decision Making Methods

1. Chi-Yo Huang
Department of Industrial Education, National Taiwan Normal University
2. Chia-Lee Yang
National center for high-performance computing
3. Ching-Chun Hsu
Department of Applied Economics and Management, National Ilan University
4. Hsing-Yen Ann
National Center for High-performance Computing

Abstract

During the past decades, air pollutions are becoming one of the most concerned issues in most economies due to the significant influences of the contaminations to the life and health of human beings. Therefore, researchers are paying more attentions to air pollutions and the corresponding effects. Derivations and analysis of research topic maps can help identify new opportunities for researchers. However, very few scholars tried to introduce the research topic maps on the study of air pollution related issues. Therefore, this study aims to introduce the research topic map to analyze the trends regarding to air pollution studies. The Microsoft Academic Graph dataset will first be mined to derive publications and keywords related to air pollutions. The top keywords will be extracted. Then, each keyword will serve as the decision variable (or the consequent) while the rest keywords will serve as the conditional variables. The Dominance Based Rough Set Approach (DRSA) will be adopted to derive the "if … then …" inference relationships. After that, the decision-making trial and evaluation laboratory (DEMATEL) technique will be used to derive the cause-effect relationships among the topics. Then, the inference relationships will be introduced into the DEMATEL, where the antecedents will serve as the causes and the consequents will serve as the effects. The research topic map being derived can serve as the basis for future researches.

Keywords： Multi-Criteria Decision Aids (Ctrl)

四、 建議

此次非常感謝「以巨量資料分析及多準則決策法萃取我國女性對 PM2.5 空氣品質之知覺、態度與政策偏好」之研究計畫慨然部份費用，能夠有機會同時參與二會，對於旅行費用的短缺，極有助益。希望若政府預算許可，可以增加單一研究計畫之補助額度。

五、 其他

無

科技部補助專題研究計畫出席國際學術會議心得報告

日期：108 年 7 月 1 日

計畫編號	MOST－107-2629- M-492-001－MY2		
計畫名稱	以巨量資料分析及多準則決策法萃取我國女性對 PM2.5 空氣品質之知覺、態度與政策偏好		
出國人員姓名	許菁君	服務機構及職稱	國立宜蘭大學應用經濟管理學系/助理教授
會議時間	108 年 06 月 23 日至 26 日	會議地點	愛爾蘭都柏林
會議名稱	30th European Conference on Operational Research (2019 EURO)		
發表題目	Exploring Gender Differences in Attitudes toward Air Pollution Based on Social Media Mining and MRDM Methods		

六、 參加會議經過

108 年 06 月 19 日至 28 日，參與楊博士主持之科技部專題研究計畫—「以巨量資料分析及多準則決策法萃取我國女性對 PM2.5 空氣品質之知覺、態度與政策偏好」，部分研究成果於愛爾蘭都柏林舉行的 2019 EURO 會議發表。

本次會議地點在都柏林大學學院(University College Dublin, UCD)，是愛爾蘭最大且歷史悠久的研究型大學，6/20-22 適逢第四屆城市未來會議(City Futures IV conference)，主題是創造公平與永續發展的城市，與本計畫執行環境政策研究議題高度相關，值得學習。

6/20 Keynote Session 邀請到 Julian Agyeman 教授專題演講，談公平永續發展的政策、規劃與實踐(Just Sustainabilities in Policy, Planning and Practice)。

6/21 Keynote Session 邀請到 Donatella Della Porta 教授專題演講，談都市移動與民主創新(Urban movements and democratic innovations)。

6/22 Oral Session 有創造公平建設，治理挑戰、智慧城市、與國家都市政策等熱門議題發表。

6/23-26 接續參加第 30 屆 European Conference on Operational Research (EURO)會議，EURO 研討會是歐洲最大型的作業研究會議，涵蓋工程、科技、管理，與人文社會等綜合性研究，巨量資料(Big Data and Data Mining)、人工智慧(Artificial Intelligence)、賽局理論(Game Theory)、機器學習(Machine Learning)的整合議題是今年亮點。各種領

域都有知名教授進行主題演講，美國 William Cook 教授專題講授巨量資料最新的行銷問題(The traveling salesman problem: postcards from the edge of impossibility)，荷蘭 Dick den Hertog 教授主講作業研究者為何要知道穩健最適化 (What every OR practitioner should know about Robust Optimization)，德國 Ulrike Reisach 教授主講人工智慧延伸的社會影響(Artificial Intelligence–How Ethics and Governance Could Contain the Manipulation of Societies)。本人對環境管理、能源政策、決策分析，與巨量資料的整合研究深感興趣，參與聆聽的主題場次也以此為主。與楊博士、師大黃教授、安博士、蕭博士、王博士等人跨領域合作，有兩篇研究於 6/25 與 6/26 進行論文報告。

6/25 於 Fuzzy Methods in MCDA 場次，是關於 Constructing Research Topic Maps for Air Pollution Researches by Text Mining and Multiple Rule Decision Making Methods 的研究，由師大黃教授進行論文報告。

6/26 於 Multiple Criteria Decision Aid and Environmental Management 場次，是關於 Exploring Gender Differences in Attitudes toward Air Pollution Based on Social Media Mining and MRDM Methods 的研究，由計畫主持人楊博士進行論文報告。

台灣與歐美有截然不同的經濟環境背景、空汙規範與民眾行為，透過這樣的互動交流，在場與會國際學者提出獨特的建議，這樣國際化的意見與分享，對於來自台灣的研究者具有莫大幫助。

七、 與會心得

很榮幸參與楊博士主持的跨領域性別主流科技計畫，透過團隊成員不同領域的專業合作，包括資訊科技、工業工程、環境科學、產業經濟等綜合性討論激盪，得以在重要的國際研討會發表，有機會能與國際學者對話與交流，進行學習，對於台灣在環境政策分析與評估研究領域都有嶄新的推出。

參與會議期間，吸收許多學術議題的最新脈動，見識到巨量資料的整合領先，瞭解永續發展關心的環境指標，更正視環保政策的長期影響。這樣的交流經驗，在心靈學習上是豐碩飽滿的，希望也能藉此檢視並反思改進自己的現況，讓自己在研究上可以有更多進步與突破的空間。誠摯感謝科技部支持，藉由國際學術會議的參與與跨領域合作的機會，擴展研究視野與累積成長經驗。

八、 發表論文全文或摘要

Exploring Gender Differences in Attitudes toward Air Pollution Based on Social Media Mining and MRDM Methods

1. Chia-Lee Yang
National center for high-performance computing
2. Chi-Yo Huang
Department of Industrial Education, National Taiwan Normal University
3. Ching-Chun Hsu
Department of Applied Economics and Management, National Ilan University
4. YiHao Hsiao
National Center for High Performance Computing
5. Yu-Tai Wang
Research Service Team, National Center for High-performance Computing, National Applied Research Laboratories

Abstract

Air pollution is one of the most concerned environmental issue due to the contaminants in the air which can disturbing human health or welfare or generating other harmful environmental impacts. Although the effects of air pollutions are harmful, people's attitudes toward towards global environmental phenomena varies. According to past works, females are more sensitive and active than males regarding to environmental impacts, and are more willing to act environmentally for a variety of reasons. This study aims to identify the gender differences regarding to air pollution based on text mining, topic modelling, and multiple rule decision making methods consisting of the Dominance Based Rough Set (DRSA), and the Decision-making Trial and Evaluation Laboratory (DEMATEL). The text mining techniques and the topic modelling technique are first introduced to derive topics from social networking sites. An inter-topics matrix consisting of keywords as condition variables and genders as decision variables will be constructed based on the text mining results. Then, the "if … then" inference relationships can be derived by using the DRSA. All the cause-effect relationships among the topics can be derived. The most interested topics by different genders can thus be derived. The proposed data-driven approach which combine big data analytics and MRDM methods can service as the guide for environmental policy definitions.

Keywords：Critical Decision Making、Analytics and Data Science、Environmental Management

九、 建議

無

十、 其他

無

107年度專題研究計畫成果彙整表

計畫主持人：楊嘉麗	**計畫編號：**107-2629-M-492-001-MY2
計畫名稱：以巨量資料分析及多準則決策法萃取我國女性對PM2.5空氣品質之知覺、態度與政策偏好（重點代號：L02.4.探討災害防治、永續發展的社會和性別影響評估）	

成果項目			量化	單位	質化（說明：各成果項目請附佐證資料或細項說明，如期刊名稱、年份、卷期、起訖頁數、證號...等）
國內	學術性論文	期刊論文	0	篇	
		研討會論文	2		1.Yu-Hsin Chen,Ben-Jei Tsuang, Kai-Chen Ku, Yu-Ru Liao, Chia-lee Yang (2020, Oct). Observation of Air Quality Response to COVID-19 in Taiwan. 2020 International Symposium on COVID-19, Taipei, Taiwan. 2.張少銘、楊嘉麗*、莊朝鈞、蕭志棋、蕭一豪（2020年10月）。運用開放資料探討新冠肺炎疫情對大眾運輸流量之影響。TANET 2020台灣網際網路研討會，台北，台灣。
		專書	0	本	
		專書論文	0	章	
		技術報告	0	篇	
		其他	0	篇	
國外	學術性論文	期刊論文	2	篇	1. Chia-Lee Yang,Chi-Yo Huang,Yi-Hao Hsiao (2021, May). Using Social Media Mining and PLS-SEM to Examine the Causal Relationship between Public Environmental Concerns and Adaptation Strategies. International Journal of Environmental Research and Public Health, 18(10), 5270,1-23. SSCI. JCR Q1 (Public, Environmental & Occupational Health), CiteScore Q2 (Public Health, Environmental and Occupational Health) .Impact Factor: 3.390 (2020) ; 5-Year Impact Factor: 3.789 (2020) 2.Chi-Yo Huang, Chia-Lee Yang, Yi-Hao Hsiao (2021, Aug). A Novel Framework for Mining Social Media Data Based on Text Mining, Topic Modeling, Random Forest, and DANP Methods. Mathematics, 9(17). SCI, JCR Q1(Mathematics), CiteScore Q1 (General Mathematics). IF 2.258

					(2020), 2.165 (5-Year).
		研討會論文	6		1. Chia-Lee Yang*, Chi-Yo Huang, Ching-Chun Hsu, Yi-Hao Hsiao, Yu-Tai Wang. Exploring Gender Differences in Attitudes toward Air Pollution Based on Social Media Mining and MRDM Methods. 30th EUROPEAN CONFERENCE ON OPERATIONAL RESEARCH (EURO 2019). Dublin, Ireland, June 23-26, 2019. 2. Chia-Lee Yang*, Chi-Yo Huang, Ching-Chun Hsu, Yu-Tai Wang. Developing Environmental Policy Instruments for Enhancing Females' Concerns based on the DANP-MV method", 25th International Conference on Multiple Criteria Decision Making (MCDM 2019). Istanbul, Turkey, June 16-21, 2019. 3.Chi-Yo Huang, Chia-Lee Yang*, China-Chun Hsu, Hsing-Yen Ann. Building a Research Topic Map toward Air Pollution By Data Mining Approach. 30th EUROPEAN CONFERENCE ON OPERATIONAL RESEARCH (EURO 2019). Dublin, Ireland, June 23-26, 2019. 4.Chia-Lee Yang*, Chao-Chun Chuang, Chang-Wei Yeh, Chang-Huain Hsieh, Ching-Chun Hsu. A Quantitative Study of Public Perceptions in Environmental Risk: Dose Gender Matter? International Conference on Advanced Technology Innovation 2019(ICATI 2019). Sapporo, Japan, July 15-18, 2019. 本人為第一作者、通訊作者. Best paper award 5.Chia-Lee Yang*, Jen-Gaw Lee, Tzu-min Chuang, Chi-Yo Huang, Jeng-Chieh Cheng, Yu Sun (2020, Feb). Public Perceptions of Air Pollution Using Geo-Social Media Data-Based Analytical Approach. 3rd Eurasian Conference on Educational Innovation 2020, Hanoi, Vietnam. MOST 6.Chia-Lee Yang,*, Yi-Lang Tasi, Hsing-Yen Ann, Hong-Ji Wei, Yi-Hua Linl" Determinants of User's Acceptance and Satisfactions on Cybersecurity Exercise System in Education: An Empirical Study.

					International Conference on Advanced Technology Innovation 2019(ICATI 2019). Sapporo, Japan, July 15-18, 2019.
		專書	0	本	
		專書論文	0	章	
		技術報告	0	篇	
		其他	0	篇	
參與計畫人力	本國籍	大專生	2	人次	擔任兼任計畫研究助理
		碩士生	5		擔任兼任計畫臨時人力
		博士生	0		
		博士級研究人員	0		
		專任人員	0		
	非本國籍	大專生	0		
		碩士生	0		
		博士生	0		
		博士級研究人員	0		
		專任人員	0		
其他成果 （無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。）			1.學術成果: 本計畫量化研究成果方面，已發表2篇Q1等級國際期刊。其中一篇為SSCI，IF為3.390，在大眾、環境與健康領域排名Q1;另一篇為SCI，IF為2.258，數學領域排名Q1，此外也發表8篇研討會論文，其中2篇獲得該會議最佳論文獎，顯現本研究跨環境與社會領域，在學術上深具研究價值。在質化方面，鑒於過去學術文獻對性別與環境相關研究十分有限，本研究從基礎性大量文獻探勘了解研究現況與缺口，以此為基礎採用近年發展迅速之社群媒體為母體，進行性別與環境認知態度模型建構，取代過去採用問卷抽樣統計方法，進而針對性別在地域差異、議題差異進一步探討，最後以決策方法提出可行政策工具，整體流程涵蓋面廣，且逐一發表出成果。 2.育才:本計畫開發之創新研究方法與應用主題，跨資訊、環境、統計、決策、地理資訊等技術，以個別型計畫規模，共聘用兼任助教級研究助理5名(其中4人為博士級)，聘用大專與碩士級學生參與擔任兼任研究助理共7人，由計畫主持人指導碩士學生(宜大與師大)共4人。 3.推廣: 本計畫計畫期間受邀至師大、宜大與台大演講共3場；除與管理與社會領域外，另與國內空污領域專家莊秉潔老師等團隊跨領域合作，初步成果發表於中研院研討會。		