國家科學及技術委員會補助專題研究計畫報告

女性對COVID-19防疫措施之認知、行為與其影響:整合巨量資料探勘、機器學習與決策分析方法

報 告 類 別 ： 成果報告
計 畫 類 別 ： 個別型計畫
計 畫 編 號 ： NSTC 111-2629-M-492-001-MY2
執 行 期 間 ： 111年08月01日至113年07月31日
執 行 單 位 ： 財團法人國家實驗研究院高速網路與計算中心

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報 告 附 件 ： 移地研究心得報告
出席國際學術會議心得報告

本研究具有政策應用參考價值：□否 ■是，建議提供機關衛生福利部
（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 113 年 11 月 06 日

中 文 摘 要 ： COVID-19 疫苗接種為全球防疫政策的核心，然國內在推動疫苗接種過程中，針對COVID-19疫苗接種行為與心理反應存在那些性別差異之量化研究相對稀缺，尤其針對女性在接種疫苗過程中，是否存在主觀認知到副作用與情緒反應。因此，本研究旨在運用巨量資料探勘、機器學習及決策分析技術，系統化分析性別在 COVID-19 疫苗接種中的認知、態度與行為反應，填補現有研究缺口。本研究計畫分為三個階段進行。第一階段，為建立台灣性別研究基礎背景，本計畫開發情境文本探勘技術，藉此技術從政府研究資料庫（GRB）的63萬件研究計畫中，比對篩選出符合聯合國永續發展目標5（SDG 5）性別平等定義的1,000多件研究計畫，進而運用文獻計量分析方法，探討過去30年台灣性別研究的發展脈絡與轉變，結果顯示出性別議題在公共政策制定中的重要性逐漸增強，且於社會與醫學研究為主，為後續研究奠定基礎。第二階段聚焦於國人COVID-19疫苗接種的認知與態度之性別差異，以資料探勘技術，從主流社群媒體中收集超過1200筆有關疫苗資料。結果顯示，11個主題中8個主題呈現出顯著的性別差異，尤其女性對於COVID-19疫苗副作用相關議題討論與男性有顯著差異。第三階段，進一步探討疫苗副作用對COVID-19疫苗接種行為，是否存在性別差異進行探討，透過另一主流社群媒體，收集大眾自我報告的疫苗接種行為與副作用資料，運用自然語言處理技術與機器學習模型，建立涵蓋年齡、性別、情緒反應與副作用的量化資料集。通過機器學習與結構方程式模型進行分析，結果顯示，年齡、性別、社群回饋與副作用在疫苗接種行為中具有顯著影響，且COVID-19疫苗接種後自我認知之副作用、性別與社群情緒之間存在顯著關係。

本研究揭示了性別差異在COVID-19疫苗接種中的影響，尤其性別對疫苗副作用的主觀認知與社群情緒反應具有顯著相關性。研究建議，疫苗接種與防疫政策應充分考慮性別差異，尤其在政策溝通與副作用議題上需注重性別敏感性。此外，由於醫療機構並無COVID-19疫苗副作用資料，傳統問卷調查無法反映即時變化，社群媒體分析提供了更動態的洞察。

中 文 關 鍵 詞 ： COVID-19疫苗, 性別差異, 疫苗副作用,資料探勘,SDG 5,社群媒體分析

英 文 摘 要 ： COVID-19 vaccination plays a pivotal role in global pandemic prevention strategies. However, in Taiwan, there is a significant lack of quantitative research addressing gender differences in vaccination behaviors and psychological responses, particularly regarding how women perceive vaccine side effects and their emotional reactions during the vaccination process. This research project aims to fill these research gaps by utilizing big data mining, machine learning, and decision analysis techniques to systematically explore gender differences in perceptions, attitudes, and behaviors related to COVID-19 vaccination. The research project is structured into three phases. The first phase seeks to establish a foundational understanding of gender research in Taiwan by developing a situational

text mining technique. This method was applied to 630,000 research projects from the Government Research Database (GRB), identifying over 1,000 projects that align with the gender equality definition under the United Nations Sustainable Development Goal 5 (SDG 5). Through bibliometric analysis, the trends and evolution of gender-related research in Taiwan over the past 30 years were analyzed. The results indicate an increasing emphasis on gender issues in public policy, particularly within social science and biomedical research, providing a crucial background for the subsequent phases of the research project. The second phase focuses on investigating gender differences in public perceptions and attitudes towards COVID-19 vaccination. Using data mining techniques, over 1,200 discussions related to vaccines were collected from major social media platforms. The analysis revealed that 8 out of 11 identified topics showed significant gender differences, especially in discussions about COVID-19 vaccine side effects, where women's attitudes and perceptions differed notably from men's. In the third phase, the research project delves deeper into how gender differences affect responses to COVID-19 vaccine side effects and how these side effects influence vaccination behavior. Self-reported vaccination behaviors and side effects were collected from another major social media platform, and natural language processing and machine learning models were applied to create a quantitative dataset that includes variables such as age, gender, emotional responses, and vaccine side effects. Machine learning and structural equation modeling revealed that age, gender, social feedback, and side effects have significant impacts on vaccination behavior, with strong correlations observed between gender, perceived side effects, and emotional reactions expressed in social media discussions. This research project underscores the importance of gender differences in COVID-19 vaccination behavior, particularly how women perceive and respond to vaccine side effects. The findings suggest that future vaccination and pandemic prevention policies should incorporate gender-specific considerations, especially regarding communication about side effects and related vaccine issues. Additionally, given that healthcare institutions lack comprehensive data on COVID-19 vaccine side effects and traditional surveys are insufficient to capture real-time behavioral shifts, social media analysis provides valuable dynamic insights into public attitudes and behaviors.

英文關鍵詞：COVID-19 vaccine, gender differences, vaccine side effects, data mining, SDG 5, social media analysis

Awareness, Attitude, and Behavior Regarding COVID-19 Prevention Policies in Taiwan: Data Mining, Machine Learning, and MCDM-Based Analyses of Gender Differences

Abstract:

COVID-19 vaccination plays a pivotal role in global pandemic prevention strategies. However, in Taiwan, there is a significant lack of quantitative research addressing gender differences in vaccination behaviors and psychological responses, particularly regarding how women perceive vaccine side effects and their emotional reactions during the vaccination process. This research project aims to fill these research gaps by utilizing big data mining, machine learning, and decision analysis techniques to systematically explore gender differences in perceptions, attitudes, and behaviors related to COVID-19 vaccination. The research project is structured into three phases. The first phase seeks to establish a foundational understanding of gender research in Taiwan by developing a situational text mining technique. This method was applied to 630,000 research projects from the Government Research Database (GRB), identifying over 1,000 projects that align with the gender equality definition under the United Nations Sustainable Development Goal 5 (SDG 5). Through bibliometric analysis, the trends and evolution of gender-related research in Taiwan over the past 30 years were analyzed. The results indicate an increasing emphasis on gender issues in public policy, particularly within social science and biomedical research, providing a crucial background for the subsequent phases of the research project. The second phase focuses on investigating gender differences in public perceptions and attitudes towards COVID-19 vaccination. Using data mining techniques, over 1,200 discussions related to vaccines were collected from major social media platforms. The analysis revealed that 8 out of 11 identified topics showed significant gender differences, especially in discussions about COVID-19 vaccine side effects, where women's attitudes and perceptions differed notably from men's. In the third phase, the research project delves deeper into how gender differences affect responses to COVID-19 vaccine side effects and how these side effects influence vaccination behavior. Self-reported vaccination behaviors and side effects were collected from another major social media platform, and natural language processing and machine learning models were applied to create a quantitative dataset that includes variables such as age, gender, emotional responses, and vaccine side effects. Machine learning and structural equation modeling revealed that age, gender, social feedback, and side effects have significant impacts on vaccination behavior, with strong correlations observed between gender, perceived side effects, and emotional reactions expressed in social media discussions. This research project underscores the importance of gender differences in COVID-19 vaccination behavior, particularly how women perceive and respond to vaccine side effects. The findings suggest that future vaccination and pandemic prevention policies should incorporate gender-specific considerations, especially regarding communication about side effects and related vaccine issues. Additionally, given that healthcare institutions lack comprehensive data on COVID-19 vaccine side effects and traditional surveys are insufficient to capture real-time behavioral shifts, social media analysis provides valuable dynamic insights into public attitudes

and behaviors.

Keywords: COVID-19 vaccine, gender differences, vaccine side effects, data mining, SDG 5, social media analysis

I. Introduction

The COVID-19 pandemic has disrupted economies and social systems worldwide, exacerbating existing gender inequalities. During the height of the pandemic, COVID-19 preventive measures, such as lockdowns, social distancing, and vaccination efforts, disproportionately impacted women, adding to already present disparities. These prevention policies have placed additional burdens on women, particularly in unpaid caregiving roles, limited their economic opportunities, and underscored gender gaps in times of crisis. Compared to men, women face more caregiving responsibilities, restricted access to economic opportunities, and higher risks of job loss due to the unequal distribution of unpaid care work (Mckinsey et al., 2020). Research indicates that women's employment is nearly twice as vulnerable to pandemic-related job loss as men's (Wenham, Smith, & Morgan, 2020). Furthermore, studies report a surge in gender-based violence during the pandemic, posing additional risks to women's health and safety (Peterman et al., 2020).

Beyond these immediate effects, COVID-19 vaccination has emerged as a central component of global pandemic prevention strategies, and growing research reveals gender differences in psychological responses and physiological health impacts related to COVID-19 vaccination. Studies indicate that men and women differ significantly in their perceptions of vaccine efficacy, safety, and necessity. Meta-analytic calculations show that significantly fewer women stated that they would get vaccinated compared to men (Zintel et al., 2023). Understanding these gender-specific perspectives is essential for developing more effective, inclusive vaccination strategies that address diverse public health needs.

Recognizing the need to understand gendered responses to COVID-19, research in Taiwan has increasingly focused on gender-based perspectives toward the COVID-19 pandemic. Studies indicate that women are generally more likely than men to view COVID-19 as a serious health threat, show a higher risk perception of the pandemic, and display greater compliance with preventive measures (Tan, Yoshida, Ma, Mauvais-Jarvis, & Lee, 2022). Women also experience lower disease incidence and lethality than men, attributed to factors such as hormonal protection, stronger immune responses, and greater adherence to safety practices, such as handwashing and following guidelines. While women's behaviors may reduce infection risk, the broader socioeconomic impacts of preventive measures continue to weigh heavily on them (Chang, 2020).

Despite these findings, gaps remain in exploring the full range of health and socioeconomic outcomes for women, underscoring the importance of research that addresses the unique challenges women face during infectious disease outbreaks. Thus, this project employs a three-

phase research approach, progressing from a macro-level analysis of gender-related research in Taiwan to targeted insights on gender differences in COVID-19 vaccination attitudes and behaviors.

1. Bibliometric Analysis of Gender-Related Research

The first phase involves a systematic analysis from Taiwan's Government Research Database (GRB). We identify projects aligned with the United Nations Sustainable Development Goal 5 (SDG 5) on gender equality, offering a bibliometric overview of gender-focused research trends over the past 30 year in Taiwan. This phase provides a foundational understanding of gender-focused research in Taiwan, serving as a basis for integrating gender studies with the fields of health and social psychology.

2. Gender Differences in Public Attitudes Toward COVID-19 Vaccination:

The second phase applies data mining techniques to analyze COVID-19 vaccine-related discussions from major social media platforms, identifying significant gender differences in public perceptions and attitudes. The analysis reveals notable disparities, particularly regarding vaccine side effects, offering insights into the distinct responses of men and women to vaccination-related topics on social media.

3. Gender Influence on Vaccination Behavior and Side Effects:

The final phase examines how gender differences impact vaccination behavior and responses to side effects. Self-reported data on vaccination behaviors and side effects are collected and analyzed using natural language processing and machine learning models, creating a dataset with variables such as age, gender, emotional responses, and vaccine-specific side effects. Results indicate the correlations between gender, perceived side effects, and behavioral responses, providing actionable insights for gender-sensitive health communication strategies in COVID-19 vaccination policies.

This research contributes to pandemic response planning by highlighting the importance of a gender-focused, data-driven approach to address existing gaps in public health strategies. By emphasizing nuanced, gender-sensitive measures, the study provides valuable insights for enhancing the inclusivity and effectiveness of Taiwan's COVID-19 vaccination policies.

II. Literature Review

The COVID-19 pandemic has underscored existing gender inequalities, affecting women disproportionately in economic, caregiving, and health-related domains. Aligned with this study's three-phase approach, the literature review first examines the importance of gender equality within the framework of global development goals, followed by the pandemic's impact on gender inequality, and finally explores gender differences in vaccine hesitancy and side effects.

1. Gender equality and Sustainable Development Goals

SDG 5, *"Achieve gender equality and empower all women and girls,"* is a foundational component of the Sustainable Development Goals (SDGs) (U. N. UN, 2015). Gender equality is not only a goal in itself but also essential for achieving other objectives, such as poverty reduction (SDG 1), quality education (SDG 4), decent work and economic growth (SDG 8), reduced inequalities (SDG 10), and inclusive societies (SDG 16) (Esquivel & Sweetman, 2016). The interconnectedness of gender equality with other SDGs is particularly evident during crises like COVID-19, which has magnified existing gender disparities. Women, who often carry primary caregiving responsibilities, face disproportionate impacts during crises, such as economic instability, restricted healthcare access, and increased risks of gender-based violence. These compounded vulnerabilities underscore the need for inclusive, gender-responsive policies in public health and economic recovery (Fortier, 2020). Effective gender-responsive policymaking relies on high-quality, gender-disaggregated data, which enables evidence-based approaches to address specific gender needs. However, substantial data gaps remain, particularly in developing countries where resources and statistical infrastructure are limited (W. UN, 2018). This study builds on the UN's framework for gender equality to analyze relevant research in Taiwan, situating Taiwan-specific findings within the broader global SDG context. By aligning with SDGs and using big data methods, this project deepens the understanding of local gender equality issues and contributes to the global pursuit of resilient, equitable societies.

2. Gender Inequality During the COVID-19 Pandemic

The COVID-19 pandemic has worsened socioeconomic hardships for women, who have disproportionately shouldered the burden (Fortier, 2020). Gender biases in the labor market have exacerbated caregiving responsibilities and economic insecurity for women, particularly in female-dominated sectors like daycare and education (Carli, 2020). Studies in the U.S., Germany, and Singapore show women are more likely than men to work from home, reduce hours, or face unemployment due to pandemic disruptions, reinforcing pre-existing inequalities in caregiving (Reichelt, Makovi, and Sargsyan (2021). The pandemic has exposed deep-rooted gender inequalities in the labor market, underscoring the need for policies to address these disparities for equitable recovery. Flexible work policies, equitable distribution of care work, and addressing gender-based violence are recommended (Foley and Cooper (2021). Although women's labor participation has risen, they still carry a larger share of caregiving, emphasizing the need for transformative social changes to equitably share these responsibilities (Alon, Doepke, Olmstead-Rumsey, & Tertilt, 2020). Despite the challenges, the pandemic offers an opportunity to drive long-term reductions in gender disparities in the labor market (Alon et al., 2020).

3. Gender Differences and Vaccine Hesitancy

Vaccine hesitancy, initially defined by the WHO in 2014 as the "delay in acceptance or refusal of vaccination despite the availability of vaccination services" (WHO, 2014), has gained renewed

attention during the COVID-19 pandemic. Larson (2022) further refined vaccine hesitancy as a state of indecision regarding vaccination, highlighting psychological factors such as doubts or concerns that persist even among those who receive the vaccine (Larson, 2022). Vaccine hesitancy is typically influenced by three factors: confidence (lack of trust in the vaccine or healthcare provider), complacency (perceived lack of necessity for vaccination), and convenience (accessibility)(WHO, 2014). During the COVID-19 pandemic, gender differences in vaccine acceptance have become a prominent focus in research. Studies indicate that gender-specific drivers of vaccine hesitancy are prominent, with women more likely to experience hesitancy due to safety concerns and limited trust (Troiano & Nardi, 2021) (Murphy et al., 2021). Given the availability of multiple COVID-19 vaccines, including Pfizer, Moderna, AstraZeneca, Johnson & Johnson, and Sinovac, this study seeks to analyze gender-based preferences regarding vaccine attributes in Taiwan, where the vaccine supply is stable. By exploring these preferences and the factors influencing vaccine acceptance, this study aims to enhance understanding of vaccine hesitancy and inform targeted strategies to address concerns and increase COVID-19 vaccination uptake.

4. Gender Differences and Vaccine Responses

Recent medical and clinical research has increasingly highlighted sex differences in vaccine responses. Studies have examined the safety and efficacy of COVID-19 vaccines for pregnant women, emphasizing considerations for both maternal and fetal health (Garg, Shekhar, Sheikh, & Pal, 2021). Additionally, research on vaccine-related blood clot risks among women has resulted in tailored recommendations for specific vaccines, particularly with regard to the AstraZeneca and Johnson & Johnson vaccines (Mahase, 2021). Other studies explore potential impacts on male reproductive health, including concerns over fertility and hormonal effects, which have been areas of focus due to public interest and vaccine hesitancy concerns (Zaçe, La Gatta, Petrella, & Di Pietro, 2022).

Gender differences in emotional responses to vaccine side effects are notable, with women generally more likely to express vaccine hesitancy, though this varies across countries (De Figueiredo, Simas, & Larson, 2023). Despite initial hesitancy, vaccination uptake among women surpassed early expectations in many places, aided by targeted campaigns, positive vaccination experiences, and policies such as vaccine passports, which helped reduce gender disparities (Zintel et al., 2023). These gender-specific responses highlight the need for targeted public health strategies to address vaccine hesitancy and promote equitable uptake. Although health and emotional responses are often studied independently, examining their interaction is crucial. A cross-disciplinary approach that integrates both perspectives provides a more comprehensive understanding of vaccine hesitancy, supporting more effective, gender-sensitive public health strategies.

III. Methodology

This study employs big data analytics, drawing data from sources such as government research project databases and social media. Therefore, a methodology combining natural language processing, text mining, and statistical analysis methods is utilized. The primary methods used in this study are outlined as follows:

1. Contextual Text Mining

Text mining is an artificial intelligence technology that employs natural language processing (NLP) to transform unstructured text found in documents and databases into structured, normalized data that is suitable for further analysis (Kao & Poteet, 2007). In recent times, text mining research has gained widespread acceptance in innovation research (Antons, Grünwald, Cichy, & Salge, 2020). However, due to the diverse nature of the available unstructured documents, text mining has become a challenging task. Contextual text mining is the process of extracting valuable information from textual data by considering the context in which the data was generated (Qiaozhu Mei & Zhai, 2006). By comparing and analyzing the variations of themes over different contexts, interesting theme patterns can be revealed. Since the topics covered in a document are usually related to the context of the document, analyzing topical themes within context can provide valuable insights. Some studies consider different types of context information, such as time trend, authorship analysis, and sub-collection (Hsiao, Chuang, Huang, Yang, & Wu, 2022).

2. Sentence-Bidirectional Encoder Representation from Transformers (SBERT)

Sentence-BERT (SBERT) is an adaptation of the Bidirectional Encoder Representations from Transformers (BERT), designed to address BERT's limitations in semantic similarity tasks. While BERT effectively captures bidirectional language representations using masked language modeling (MLM) and next sentence prediction (NSP), it struggles with sentence-level semantic similarity due to high computational costs and the need for paired sentence input (Emich, Kumar, Lu, Norder, & Pandey, 2020). To overcome these issues, Reimers and Gurevych developed SBERT, which employs siamese and triplet network structures to produce meaningful sentence embeddings that capture semantic nuances. These embeddings allow for efficient and accurate sentence similarity comparisons, making SBERT particularly useful for tasks such as sentence similarity, paraphrasing, and clustering. SBERT's network structure enables more efficient sentence embedding generation, significantly enhancing performance on various NLP tasks without extensive computational demands(Reimers & Gurevych, 2019).

3. Sentiment Analysis

Sentiment analysis, also known as subjectivity analysis, opinion mining, or appraisal extraction, has connections to affective computing, where computers recognize and express emotions (Mejova, 2009). Its primary goal is to capture the writer's or speaker's attitude, which may reflect personal judgment, emotion, or evaluative intent. By using Natural Language Processing (NLP) and information extraction techniques, sentiment analysis can classify expressed sentiments as positive

or negative, analyzing large sets of text data to identify these patterns in comments, questions, and requests. Although many applications rely on the bag-of-words model, this approach often overlooks the context necessary for a nuanced analysis. To enhance accuracy, common supervised and data-driven methods such as Naïve Bayes, Maximum Entropy, and Support Vector Machines (SVM) are frequently employed. In essence, sentiment analysis seeks to understand a writer's mood, judgment, or evaluation, capturing the overall sentiment or polarity within a document.

4. Bibliometric Analysis

Bibliometric analysis, first defined by Alan Pritchard in 1969 as the "application of mathematics and statistical methods to books and other media of communication," offers insights into scientific research patterns and trends (Lawani, 1981). This method evaluates academic impact and interdisciplinarity by analyzing citation networks across papers and journals (Leydesdorff & Rafols, 2011). Key principles in bibliometrics include Bradford's law, which organizes journals by decreasing productivity, with article numbers proportional to the reciprocal of each group number (Brookes, 1969), and Lotka's law, suggesting the number of authors with k publications is inversely proportional to 1/k^2 (Rousseau & Rousseau, 2000). Additionally, Zipf's law estimates word frequencies by their rank, and Price's law describes productivity distribution among institutions, while the Law of Concentration highlights publication clustering among a limited number of countries (Hood & Wilson, 2001). This study utilizes bibliometric analysis to systematically examine research trends, author contributions, and interdisciplinary influences within the field.

5. Logistic Regression

Logistic Regression, introduced and popularized by Joseph Berkson in 1944, is a statistical model distinct from linear regression because it does not require a linear relationship between dependent and independent variables. This flexibility makes it widely applicable in fields such as machine learning, medicine, and social sciences (Kleinbaum, Dietz, Gail, Klein, & Klein, 2002). Logistic Regression relies on the logistic (or sigmoid) function, which converts predictions into probabilities between 0 and 1. By estimating coefficients for predictors, the model maximizes the likelihood of observed data to predict categorical outcomes effectively. Recent advancements, such as regularization, have improved its performance in data mining and high-dimensional data, enhancing model interpretability and accuracy (Komarek, 2004). This balance of simplicity and predictive capability makes Logistic Regression a useful tool for analyzing complex datasets, aligning well with the objectives of this study.

6. Random Forest

Random Forest is a machine learning algorithm that combines the outputs of multiple decision trees to achieve a single result (Breiman, 2001). Its ease of use and flexibility have made it widely adopted for classification and regression tasks, particularly for handling complex, high-

dimensional datasets. The algorithm uses an ensemble of decision trees, each trained on a bootstrap sample with a random subset of features at each split, reducing tree correlation and improving model stability. For classification, Random Forest determines the final output by majority voting among trees, while in regression, it averages predictions across trees. Its structure minimizes overfitting and provides a built-in feature importance measure, which identifies key variables for prediction accuracy, making it ideal for feature selection, especially in big data (Genuer, Poggi, Tuleau-Malot, & Villa-Vialaneix, 2017).

IV. Research Results

This project aims to systematically explore Awareness, Attitude, and Behavior Regarding COVID-19 Prevention Policies in Taiwan by employing data mining, machine learning, and MCDM-based analyses to reveal gender differences. To ensure a comprehensive analysis, a three-phase approach was implemented, drawing from various data sources and utilizing distinct analysis methods tailored to each phase's objectives. A summary is provided in the table 1.

Table 1. 3 Phase Research Plan

Phase	Research Purpose	Data Source	Analysis Method
1.Bibliometric Analysis of Gender-Related Research	To analyze Taiwan's Government Research Database (GRB) for projects aligned with United Nations SDG 5 on gender equality, offering a bibliometric overview of gender-focused research trends over the past 30 years.	Taiwan Government Research Database (GRB)	Natural Language Processing (NLP), SBERT Bibliometric analysis
2. Gender Differences in Public Attitudes Toward COVID-19 Vaccination	To analyze COVID-19 vaccine-related discussions on major social media platforms, identifying significant gender differences in public perceptions and attitudes, particularly regarding COVID-19 vaccine side effects.	Social Media, Dcard	NLP, Text miming, Topic Modeling, Univariate statistical analysis, Logistic regression
3. Gender Influence on Vaccination Behavior and Side Effects	To examine how gender differences impact vaccination behavior and responses to side effects, using self-reported data to analyze correlations between gender, perceived side effects, and behavioral responses.	Social Media, PTT	Data mining, Randon Forrest, sentiment analysis, LLM GPT

4.1. Bibliometric Analysis of Gender-Related Research

4.1.1 Data source and analysis

This study utilizes the GRB as the primary data source and adopts a mixed-methods approach to build the gender database and analyze the data. The Government Research Bulletin (GRB) serves as the official platform for disseminating information on government-funded science and technology research projects in Taiwan, providing comprehensive and influential data on research projects in the country (STPI, 2023). We collected 634,283 research projects in GRBs from 1993 to October 2022.

To focus on gender equality-related projects, descriptions of the United Nations' SDG 5 goals, targets, and indicators were extracted as reference points. Using the SBERT (Sentence-BERT) method, we compared project names and abstracts from the GRB to these SDG 5 descriptions to identify relevant projects. Expert-defined threshold values were then applied to refine the selection, ultimately identifying 1,011 projects aligned with SDG 5 goals. Among the keywords analyzed (a total of 3,060 words), frequently occurring terms included "gender," "sexual," "education," "equality," "health," "technology," "women," "discrimination," "rights," "social," "female," "sex," "violence," and "legal." Following data selection, a bibliometric analysis was conducted to systematically analyze these 1,011 projects, identifying trends, research focus areas, and growth patterns within gender equality research.

4.1.2. Bibliometric Analysis Results

The analysis of gender equality research projects over the past 30 years reveals distinct growth phases. Initially, from 1993 to 2006, the number of projects was minimal, indicating limited early engagement in gender-focused research. This shifted in the second phase, from 2007 to 2018, where there was a marked increase, peaking in 2009 with nearly 80 studies, reflecting heightened awareness likely spurred by global advocacy and alignment with United Nations SDGs. However, the third phase, from 2019 to 2022, displayed fluctuations, with a low in 2019 of only 4 studies, followed by subsequent increases. This variability may result from competing research priorities and shifting funding allocations. Regarding research types, fundamental research constitutes 53% of all studies, followed by applied research at 36%, though applied research has decreased since 2018 due to constraints in funding and practical challenges. Funding sources reveal a reliance on academic grants, comprising 84% of the total, with minimal commissioned research support. The National Science and Technology Council (NSTC) supervises 84% of these projects, emphasizing its role in promoting gender studies. Other agencies, such as the Ministry of Health and Welfare (MOHW) and the Council of Agriculture (COA), play smaller roles, focusing on healthcare and agriculture-related gender issues (see Fig. 1).

The distribution of principal investigators shows that 57% of projects had a single lead, while only 30% had 2–3 co-investigators, indicating a preference for specialized, single-topic studies over interdisciplinary research. This trend may reflect limited resources and researchers' focus on deepening individual expertise. In the context of COVID-19, this concentrated approach may affect how gender issues are integrated into public health responses. Addressing gender differences in COVID-19 awareness, attitudes, and behaviors requires a more collaborative, interdisciplinary approach across public health, social science, and data science fields. This highlights a need to diversify funding and encourage broader collaboration to address gender-related challenges effectively.

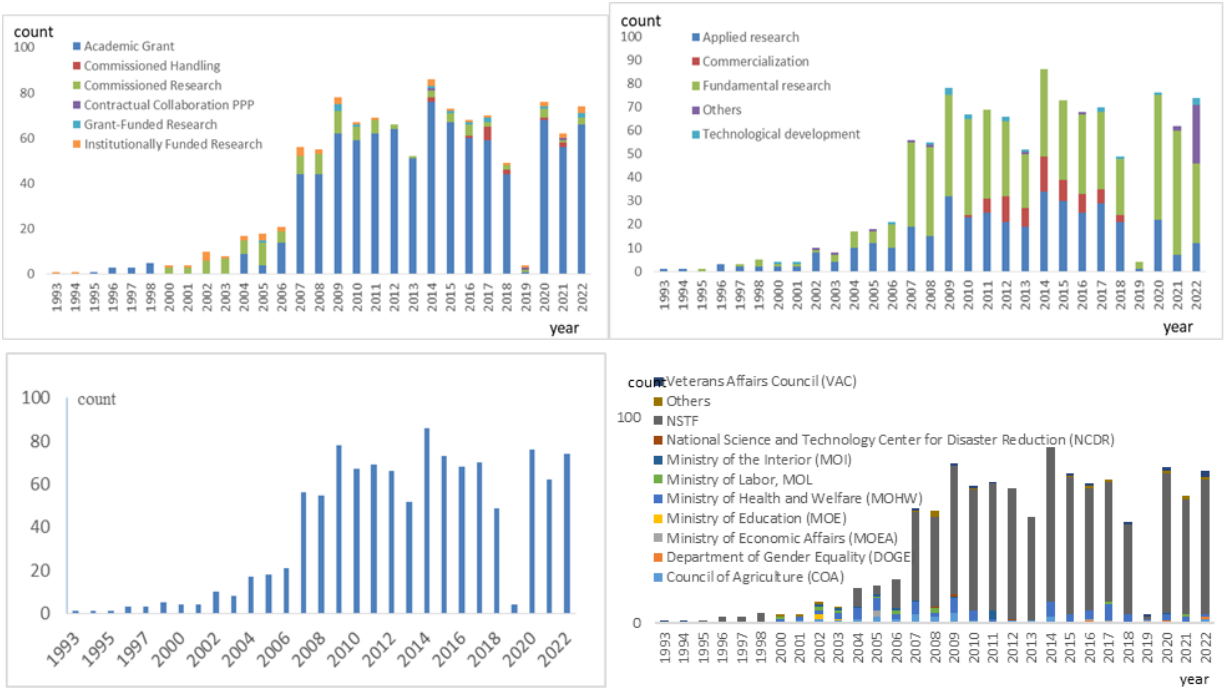

Fig. 1. Development Trends in SDG 5 Research Projects

4.2 Gender Differences in Public Attitudes Toward COVID-19 Vaccination

4.2.1 Data source and analysis

In July 2023, Dcard (dcard.tw), a popular platform with over 4 million users generating about one-sixth of Taiwan's weekly social media posts, was used to collect user opinions on keywords related to COVID-19 vaccines. A total of 1,284 posts were retrieved via Dcard's API. The data was processed using Python libraries, with JSON parsing for initial handling and Pandas for data manipulation. Messages unrelated to COVID-19 vaccines were removed, resulting in a final dataset of 1,200 posts ready for analysis.

Text cleaning involved removing punctuation, common stop words, duplicates, infrequent terms, and irrelevant phrases. The SnowNLP library was used to process stop words, with further customization for Dcard-specific vocabulary. Tokenization was performed using Jieba, a popular Chinese tokenization tool, with domain-specific words added to the dictionary to improve accuracy.

After preprocessing, the Latent Dirichlet Allocation (LDA) model was applied to uncover underlying themes within the data. LDA enables probabilistic topic modeling, assigning words to topics based on co-occurrence patterns and providing a nuanced view of topic distribution within the text. Model parameters were fine-tuned through 1,000 iterations of Gibbs sampling to ensure high-quality topic identification. The optimal number of topics was determined using topic

coherence scores, which evaluate topic interpretability based on word co-occurrence patterns, leading to the selection of 11 topics. These 11 clusters represent various public discussions on COVID-19 vaccines, including vaccine efficacy, side effects, distribution policies, and public perceptions.

4.2.2 Public Attitudes Toward COVID-19 Vaccination Results

Analysis of public concerns about COVID-19 vaccination revealed distinct topic preferences between genders across 11 identified themes. The most prominent topics for females included "Vaccine Myths and Misinformation" (248 posts), "Scientific and Medical Insights" (57 posts), and "Vaccine Hesitancy and Concerns" (24 posts). In contrast, males showed high engagement in "Scientific and Medical Insights" (248 posts), "Vaccine Efficacy and Protection" (85 posts), and "Vaccine Hesitancy and Concerns" (89 posts). These differences suggest that while both genders expressed significant interest in scientific aspects and personal vaccination beliefs, females displayed a stronger focus on myths and misinformation, while males emphasized vaccine efficacy and protection.

Table 2. Public Concern Topics Toward COVID-19 Vaccination by Gender

Topic	**Topic 1**	**Topic 2**	**Topic 3**	**Topic 4**	**Topic 5**	**Topic 6**
Theme	Vaccine Efficacy and Protection	Side Effects and Adverse Reactions	Vaccine Choices and Preferences	Vaccine Hesitancy and Concerns	Government Policies and Regulations	Vaccine Accessibility and Distribution
Female	20	4	3	24	13	13
Male	85	25	9	89	60	7

Topic	**Topic 7**	**Topic 8**	**Topic 9**	**Topic 10**	**Topic 11**
Theme	Personal Vaccination Experiences	Immunity and Health Implications	Public Opinion and Social Influence	Scientific and Medical Insights	Vaccine Myths and Misinformation
Female	7	6	13	57	248
Male	44	9	45	248	83

The T-test analysis reveals significant gender differences across COVID-19 vaccination topics, with distinct focus areas for males and females. Topics showing significant gender differences include Topic 1: Vaccine Efficacy and Protection ($p=0.001$), Topic 2: Side Effects and Adverse Reactions ($p=0.033$), Topic 4: Vaccine Hesitancy and Concerns ($p<0.001$), Topic 5: Government Policies and Regulations ($p=0.003$), Topic 6: Vaccine Accessibility and Distribution ($p=0.002$), Topic 7: Personal Vaccination Experiences ($p=0.001$), Topic 10: Scientific and Medical Insights ($p<0.001$), and Topic 11: Vaccine Myths and Misinformation ($p<0.001$). Strongest differences appeared in Topic 10 and Topic 11, where males emphasized scientific details and females focused more on misinformation concerns. Gender also significantly impacted overall sentiment ($p=0.044$),

with females expressing more concern around myths and safety and males adopting a more analytical stance on efficacy. Topics where gender differences were not significant include Topic 3: Vaccine Choices (p=0.073), Topic 8: Immunity Implications (p=0.160), and Topic 9: Public Opinion (p=0.255), suggesting these resonate similarly across genders. These findings highlight the importance of tailoring public health messages by addressing misinformation and safety for females and providing efficacy and scientific support for males to improve vaccination engagement and trust.

Table 3. T-Test Results for Gender Differences in Public Concern Topics

Topic	F-Value	T -value	df	Sig
Topic 1	30.688	-3.414	1110.135	0.001
Topic 2	13.405	-2.140	1237.147	0.033
Topic 3	10.640	-1.797	974.212	0.073
Topic 4	27.702	-3.515	1001.124	0.001
Topic 5	28.820	-2.993	1074.287	0.003
Topic 6	45.336	3.139	569.899	0.002
Topic 7	30.713	-3.380	1189.575	0.001
Topic 8	8.383	1.408	656.920	0.160
Topic 9	4.114	-1.140	929.936	0.255
Topic 10	79.654	-7.220	1038.743	0.000
Topic 11	21.306	12.712	754.175	0.000
Sentiment	7.235	-2.020	814.795	0.044

Further analysis using logistic regression was conducted to predict sentiment with topics and gender as predictors. The logistic regression results show that Topic 4: Vaccine Hesitancy and Concerns ($p = 0.018$, $Exp(B) = 0.378$), Topic 6: Vaccine Accessibility and Distribution ($p = 0.004$, $Exp(B) = 0.167$), and Topic 11: Vaccine Myths and Misinformation ($p = 0.022$, $Exp(B) = 0.450$) are significantly associated with a reduced likelihood of positive sentiment, even when controlling for gender as a covariate. This suggests that these topics are more likely to generate negative sentiment regardless of gender, marking them as crucial targets for public health messaging. Topics 1, 2, 5, 7, and 10, however, did not show a significant impact on sentiment, indicating they may not strongly affect the sentiment outcome once gender is accounted for. Gender itself, as a covariate ($p = 0.972$), does not significantly predict sentiment independently in this model, reinforcing that topic-specific influences primarily drive sentiment. These insights underscore the importance of addressing topics like hesitancy, accessibility, and misinformation to effectively manage and potentially enhance public sentiment around vaccination.

Table 4 Logistic Regression Analysis of Topics and Gender in Predicting Sentiment

	B	S.E.	Wald	df	**Sig**	Exp(B)
Topic 1	0.403	0.469	0.736	1	0.391	1.496
Topic 2	0.947	0.718	1.740	1	0.187	2.579
Topic 4	-0.972	0.412	5.576	1	0.018	0.378
Topic 5	-0.651	0.452	2.076	1	0.150	0.522
Topic 6	-1.792	0.624	8.249	1	0.004	0.167
Topic 7	-0.069	0.514	0.018	1	0.894	0.934
Topic 10	-0.067	0.375	0.032	1	0.858	0.935
Topic 11	-0.799	0.349	5.247	1	0.022	0.450
gender	0.005	0.146	0.001	1	0.972	1.005

Although gender was included as a covariate, there was no detailed examination of its specific impact on emotional responses to vaccine side effects. Thus, a third research phase will analyze gender-based emotional differences in side effect discussions, adding emotional variables to explore potential gender interaction effects.

4.3 Gender Influence on Factors Affecting Vaccination Hesitancy

This study explores how gender influences factors associated with COVID-19 vaccine hesitancy, focusing on side effects, emotional responses, and vaccine brand preferences. Vaccine hesitancy remains a significant barrier to widespread immunization, often influenced by perceived risks, side effects, and brand reputation. This research aims to answer two key questions: What factors drive individuals' vaccine brand selections, and how does gender play a role in shaping these choices and associated emotional responses?

4.3.1 Data Source and Analysis Methods

Data was sourced from Taiwan's prominent social media platform, PTT, specifically from its COVID-19 board, covering posts from May 17, 2021, to April 8, 2022. Individuals posted self-reported vaccination experiences, creating an unstructured dataset, which was organized into a structured database. Variables included age, gender, engagement level (upvotes), vaccination time and place, vaccine brands, and doses received. To investigate the impact of these variables, especially regarding gender, on vaccine brand choice and sentiment, two analytical methods were applied: Random Forest Regression (RFR) and Logistic Regression (LR). These models enabled a nuanced analysis of factors like age, engagement level, prior side effects, and their correlations with vaccine brand preference and sentiment.

4.3.2 Gender Influence on Factors Affecting Vaccination Hesitancy Results

The dataset contained 1,473 entries, with an average participant age of 35.2 years; 49.6% were male, and 50.4% were female. Engagement level, measured by the average number of likes per

post (9.75), was factored in to assess the influence of social validation on brand choice. Self-reported side effects showed for the first dose, individuals reported an average of 1.96 types of side effects, such as fever and headache, which reduced to 0.52 for the second dose and further to 0.26 for additional doses. This pattern closely reflected vaccine availability and brand distribution in Taiwan, with AstraZeneca, Moderna, Medigen, and BNT as the primary brands chosen.

Table 5. Basic Information in Self-Reported COVID-19 Vaccination

Variable	Distribution
Age	Average 35.2, SD 12.37
Gender	Male 717(49.6%), Female 730 (50.4%)
Up votes	Average 9.75, SD 15.34
1st dose side effects	Average 1.96, SD 1.81
2nd dose side effects	Average 0.52, SD 1.19
Additional dose side effects	Average 0.26, SD 0.88

Table 6. Vaccine Brand selection in Self-Reported COVID-19 Vaccination

Vaccine name	1st Dose	2nd Dose	Additional Dose
AZ	780	218	138
Moderna	173	67	18
Medigen	380	153	72
BNT	126	36	15
Sinovac	3	3	2
Johnson & Jonson	2	1	NA
Sinopharm	1	1	1
UBI	4	4	3
missing	4	33	7
Total	1473	516	256

Table 7. Vaccine Brand selection in Self-Reported COVID-19 Vaccination

	Reactions after 1st Vaccination	Total
A	Tired	393
B	Headache**	300
C	Dizziness	179
D	nausea and vomiting	74
E	increased hunger	135
F	decreased hunger	46
G	Diarrhea	63
H	Fever**	421
I	Chills	328
J	Muscle or joint pain	789
K	allergic bruising	36

L	swollen lymph nodes in the face**	10
N	Heart discomfort**	58
O	chest discomfort	37
P	irregular periods	14

Further analysis of the additional dose choices, especially the third dose, highlighted the influence of prior experience. Random Forest analysis showed that age and gender were significant predictors for third-dose brand preference, particularly for Moderna and Medigen, followed by engagement level, initial side effects, and gender. For BNT, the engagement level and initial side effects were particularly impactful, suggesting that both past experiences and social perception influence vaccine brand choice

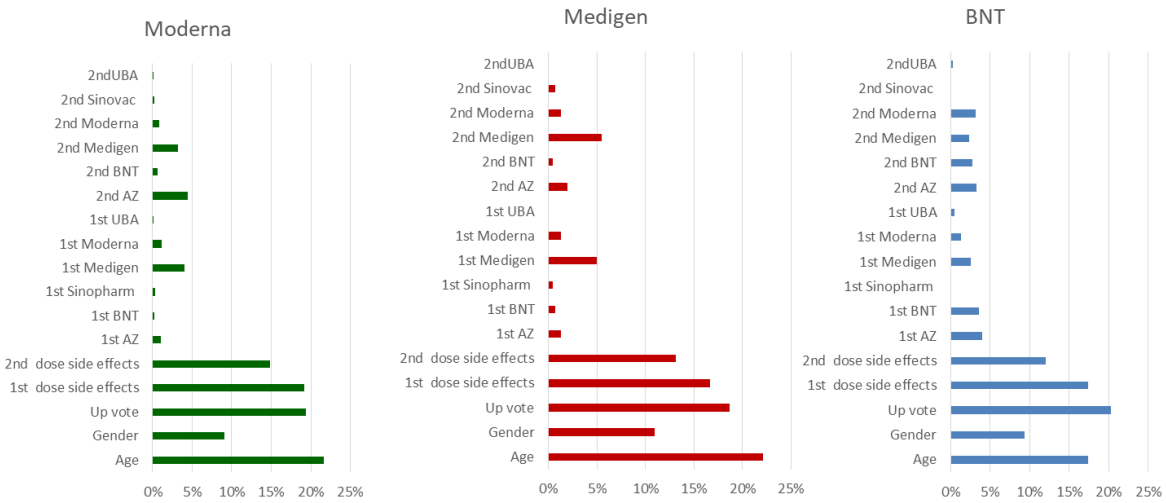

Fig. 2. Factors Influencing Brand Selection for Additional COVID-19 Vaccine Doses by using Random Forest (RF)

To examine gender-specific differences in emotional responses to side effects, a logistic regression analysis was conducted. Results indicated significant differences in how men and women responded emotionally to side effects. For women, both the severity and the total number of side effects from the first dose were significantly associated with negative sentiment. In contrast, for men, only the severity of side effects influenced negative sentiment, while the total number of side effects did not have a significant impact. These results underscore gender-specific emotional responses, suggesting that women may experience a heightened negative sentiment due to both the severity and number of side effects, while for men, only severe side effects were associated with negative sentiment.

Table 8. Logistic Regression Analysis of side effect and Gender in Predicting Sentiment

	Unstandardized Coefficients	β	T	Sig.

	B	Std.			
Women*1st dose side effect severity	-.107	.054	-.182	-1.987	0.047**
Men*1st dose side effect severity	-.228	.060	-.391	-3.784	0.000***
Women*1st dose side effect total	-.088	.015	-.329	-5.986	0.000***
Men*1st dose side effect total	.012	.044	.022	.262	0.794

V. Conclusion

This study investigates gender-based dynamics in public awareness, attitudes, and behaviors regarding COVID-19 prevention policies in Taiwan through a three-phase analysis using data mining, machine learning, and multi-criteria decision-making (MCDM) methods. Focusing on COVID-19 vaccination, the research examines gender differences through data sources, including Taiwan's Government Research Database (GRB), Dcard, and PTT. These findings significantly contribute to understanding how gender influences public perception, decision-making, and compliance with health interventions, underscoring the need for gender-sensitive approaches in public health policy and communication.

The first research phase provides an in-depth examination of Taiwan's historical research capacity in gender-focused public health, marking the first instance of using data mining techniques in a bibliometric study within this context. Through a comprehensive analysis of Taiwan's Government Research Database (GRB), this phase maps research trends aligned with Sustainable Development Goal 5 (SDG 5) on gender equality and establishes a pioneering methodology for identifying research gaps and emerging themes in gender-related health studies. This innovative data mining approach offers a nuanced overview of how gender considerations have evolved within Taiwan's research landscape over the past 30 years, setting a new standard for bibliometric studies in public health policy analysis.

In the second phase, this study analyzed gender-based differences in public attitudes toward COVID-19 vaccination using discussions from Taiwan's Dcard platform, revealing distinct gender patterns in vaccine-related concerns and sentiment. Results show significant differences across topics such as vaccine efficacy, side effects, hesitancy, government policies, accessibility, personal experiences, scientific insights, and misinformation. Specifically, males focused more on scientific efficacy, while females expressed greater concern around misinformation and vaccine safety, indicating a more cautious, safety-driven approach among females and a more analytical, efficacy-focused stance among males. Logistic regression further showed that vaccine hesitancy, accessibility, and misinformation significantly predict negative sentiment across genders, highlighting these topics as universal concerns likely to evoke negative responses. These findings underscore the importance of targeted messaging that addresses common concerns while also tailoring information to alleviate specific gender-based fears. Although gender itself did not independently predict sentiment, these topic-specific insights suggest that gender-sensitive health

communication can be beneficial. Public health messaging that addresses misinformation and safety concerns for females and emphasizes scientific reassurances for males could strengthen public trust and improve vaccination engagement. This study thus advocates for a gender-responsive approach in public health communication, recognizing the nuanced ways in which males and females process health information.

In the third phase, this study investigated gender differences in vaccination behaviors and emotional responses to side effects, using self-reported data from PTT, a major social media platform in Taiwan. The analysis began by examining third-dose vaccine preferences, where prior experiences with previous doses emerged as key influences on brand selection. A Random Forest analysis identified age and gender as primary predictors for third-dose choices, particularly favoring Moderna and Medigen. Engagement level and initial side effects also significantly impacted brand choice, suggesting that both personal experiences and social factors play a role in the decision-making process. Specifically for the BNT vaccine, engagement level and the severity of side effects were especially impactful, indicating that the cumulative effect of social perception and initial reactions influences booster dose selection. To further explore gender-specific emotional responses to side effects, a logistic regression analysis was conducted, revealing distinct emotional patterns between men and women. For women, both the severity and total number of side effects from the first dose were significantly associated with negative sentiment, suggesting that multiple side effects amplify emotional responses. In contrast, men's negative sentiment was primarily influenced by the severity of individual side effects, with the total number having little impact. These findings indicate that women may experience heightened negative sentiment due to both the frequency and intensity of side effects, while men's emotional responses are more directly tied to the seriousness of individual side effects. These insights underscore the need for tailored public health communications that address these gender-specific responses, setting clear expectations around side effects to support informed and confident vaccination decisions across genders.

VI. Contributions

1. Methodological and Thematic Contributions to Gender Research

This research project significantly advances gender research through both its methodological rigor and thematic scope. Using a quantitative approach across three phases, it integrates data mining, machine learning, and multi-criteria decision-making (MCDM) techniques to analyze gender-based differences in public health attitudes and behaviors. It is notably the first project to utilize data mining in a bibliometric analysis of Taiwan's public health research, establishing a foundation for detecting gender-related research gaps and identifying emerging themes in health studies. Thematically, this research project broadens gender studies by examining key health dimensions—awareness, attitude, and behavior—related to COVID-19 vaccination, offering a deeper understanding of gender-specific influences in public health.

2. Practical Contributions to COVID-19 Vaccine Public Health Strategy

The project's findings provide actionable insights for public health strategies on COVID-19 vaccination. By identifying gender-specific concerns, such as women's heightened anxiety about vaccine side effects and misinformation and men's focus on scientific efficacy, this research highlights the need for tailored, gender-sensitive messaging. Addressing safety concerns and misinformation for female audiences, while reinforcing scientific efficacy for male audiences, can foster public trust and encourage vaccination uptake. This research project also demonstrates the value of real-time social media data mining as a tool for tracking public sentiment, allowing health officials to adapt communication strategies responsively. The research contributes a foundational framework for developing inclusive health policies that recognize gender-based behavioral patterns, thereby supporting more resilient, informed, and effective public health interventions.

3. Manpower and Data Contributions to COVID-19 Open Data Website

This research project devotes manpower and resources to sustaining Taiwan's primary open data platform for COVID-19 vaccine and pandemic information, the COVID-19 Epidemic Map website (https://covid-19.nchc.org.tw/). Throughout the pandemic, this platform has been an indispensable resource, providing data that has supported over 200 master's and doctoral theses, more than 100 journal articles, and multiple institutions and research organizations. Acknowledging the platform's voluntary foundation and limited resources, the project team has assumed principal roles as developers and maintainers, handling the collection and consistent updating of CDC data to ensure that the public receives timely and accurate pandemic in formation.

4. Promoting Taiwan's Membership in the International Gender Organization WHPC

This project underscores the importance of computational methods in gender-focused research, leading to the establishment of the *Women in HPC (WHPC)* Taiwan chapter in 2023. Affiliation with the globally recognized *Women in HPC* organization reflects the team's commitment to promoting gender equality and representation in high-performance computing, an area traditionally dominated by men. Through WHPC, the project creates a collaborative space for researchers, providing training, resources, and networking opportunities that encourage the integration of gender-sensitive perspectives in computational research. This contribution extends beyond the immediate goals of the project, fostering an inclusive environment within Taiwan's HPC community and advancing computational methods that enhance gender-sensitive research frameworks across various fields.

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附件四

國家科學及技術委員會補助專題研究計畫

執行國際合作與移地研究心得報告

日期：113 年 10 月 22 日

計畫編號	NSTC－111－2629－M－492－001-MY2		
計畫名稱	女性對 COVID-19 防疫措施之認知、行為與其影響:整合巨量資料探勘、機 器學習與決策分析方法		
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
出國時間	113 年 06 月 25 日至 113 年 07 月 14 日	出國地點	University of Sussex,英國
出國研究目的	□實驗 ■田野調查 □採集樣本 ■國際合作研究 ■使用國外研究設施		

一、 執行國際合作與移地研究過程

本次移地研究獲邀以訪問學者(Visiting Research Fellow)身分前往 University of Sussex，主要因本計畫探討疫情期間性別在防疫措施中的行為模式及影響，將計算方法如巨量資料探勘、機器學習與決策分析等量化方法，用於社會科學領域研究，屬於計算社會科學（Computational Social Science）範疇。由於此領域在歐洲發展較早，台灣尚未普及，為推動本研究與社會科學的深入融合，遂進行此次移地研究。選擇前往英國 University of Sussex 的主要原因，是該校發展研究在全球研究領域具有領先地位，且其社會教育研究以質化及落地到實務應用聞名。布萊頓市也是全球性別多元研究的發源地之一，故以此進行性別偏見研究與大數據分析的跨學科合作。

本次研究行程於 6 月 25 日從台灣出發，並於 6 月 26 日抵達倫敦，隨即前往布萊頓市。6 月 27 日完成報到程序，並與校方進行身份確認與行政手續的辦理。6 月 28 日校方提供專人進行設施介紹，提供訪問學者專屬辦公室、IT 帳號、圖

書館等使用權限，並與系所主管交流，作為訪問期間移地研究準備。

在第一週，進行了 4 場訪談與合作討論，與四位學者深入探討性別與科技應用，並參與系內會議和一場人工智慧工作坊。首先，與一位來自加拿大大學的訪問學者，討論 AI 技術在非洲區域衝突中應用及新數位殖民主義的潛在影響，關注 AI 在不同社會背景下的影響力。接著，與社工系教授討論社會工作研究中的性別議題。第三場討論著重於量化技術如何輔助質化分析，並正式與 University of Sussex 老師啟動 COVID-19 性別及老年社會偏見的研究計畫構想，雙邊同意進行合作研究。第三天訪問則探討大數據技術在社會工作與教育中的潛力，研究如何利用數據驅動技術提升社會服務的精準度。參加的人工智慧工作坊，則是 AI 在教育場景中的實際應用及面臨的挑戰。

第二周則另外進行 3 場訪談，包含與兒童與青少年創新研究中心學者探討性別與數位科技、與教育學者討論 Big data 用於 literature review 潛力等。另於 7 月 9 日向該校教職員與學生進行一場學術演講，介紹如何利用大數據技術增強質化研究的效率，並分享實際案例。其餘時間則參加學生的研究論文發表會，並與學生分享了研究經驗。7 月 14 日前往倫敦參加國際研討會，進行學術論文發表，相關訪談對象與細節，涉及個資與研究內容，另存查於本單位內部。

二、 研究成果

此次移地研究成果豐富，包括發表了一場學術演講（實體與線上同步），介紹如何利用計算技術增強或加速質化研究，促進跨學科合作機會。與 8 位以上學者進行訪談，並啟動了兩項學術研究計畫，分別針對女性對 COVID-19 防疫措施的認知與行為，以及老年歧視問題。研究期間同時收集樣本資料，並進行了 Computational Social Science 的前瞻性調查，並其他學校如牛津大學學者建立了合作聯繫等。透過本次訪問，激發出更深度跨領域研究想法，二個月內促成了一篇研究論文，該論文已被國際高速計算研討會 SC24 接受。

三、 建議

本研究透過整合資料探勘、機器學習與決策分析等跨領域方法，為社會科

學研究者帶來極大的吸引力，激發彼此在社群媒體分析、文獻綜述及質化問卷分析合作研究可能性。但也發現計算科學與社會科學存在極深的鴻溝，建議台灣學界積極推動計算社會科學（Computational Social Science），結合質化研究與量化計算技術，助於解決實際社會問題，並大幅提升學術研究的效率與科學影響力。

四、本次出國若屬國際合作研究，雙方合作性質係屬：(可複選)

■分工收集研究資料
■交換分析實驗或調查結果
■共同執行理論建立模式並驗証
□共同執行歸納與比較分析
□元件或產品分工研發
□其他 (請填寫) _____

五、其他

無

國家科學及技術委員會補助專題研究計畫出席國際學術會議

心得報告

日期:113 年 10 月 22 日

計畫編號	NSTC－111－2629－M－492－001-MY2		
計畫名稱	女性對 COVID-19 防疫措施之認知、行為與其影響:整合巨量資料探勘、機器學習與決策分析方法		
出國人員姓名	黃啟祐	服務機構及職稱	國立臺灣科技大學科技管理研究所教授
會議時間	113 年 07 月 15 日至 113 年 07 月 28 日	會議地點	英國、捷克
會議名稱	1. 2024 社群媒體與社會國際研討會 International Conference on Social Media & Society 2024 2. 第三十三屆國際心理學大會 33rd International Congress of Psychology		
發表題目	1.Social Media and Gender Dynamics: Emotional Reactions to COVID-19 Vaccination 2.Gender Differences in Psychosocial and Physiological Responses to COVID-19 Vaccination 3.Developing a Comprehensive Framework for Identifying and Evaluating Gender Bias In Chinese LLMs		

一、 參加會議經過

職有幸參與國家高速網路與計算中心楊嘉麗博士所主持，「女性對 COVID-19 防疫措施之認知、行為與其影響：整合巨量資料探勘、機器學習與決策分析方法」計畫，共同研究，為瞭解全球最新性別研究及社群媒體相關研究之發展趨勢，促進與與國際學術社群交流與互動，職與楊博士投稿 7/16-18

於英國倫敦傳媒學院 (London College of Communication) 舉行的 「2024 國際社群媒體及社會研討會」(International Conference on Social Media & Society 2024，SM&S 2024) 以及 7/21-26 於捷克布拉格舉辦的「第 33 屆國際心理學研討會」 (The 33rd International Congress of Psychology，ICP 2024)獲接受，並奉准參加二研討會。SM&S 2024 是一個專注於社群媒體研究的跨領域學術會議，而 ICP 2024 則是全球心理學領域最具指標性的國際學術盛會之一，每四年舉辦一次，以下乃針對本次參加研討會之過程，所發表之研究內容與研究社群之互動學習的最新知識報告。

由於兩會議分別於 7/16-18 日及 7/21-26 於倫敦與布拉格舉行，職於 7/15 日啟程，於倫敦時間 7/15 晚上抵達，並於 7/17 日下午以海報方式發表與楊嘉麗博士、輔仁大學陳泓勳教授合著之「Social Media and Gender Dynamics: Emotional Reactions to COVID-19 Vaccination」一文，以 COVID-19 防疫措施為主題，探討社群媒體上的知覺與行為，與本計畫研究主題以及研討會主題緊密相關。於 SM&S 2024 結束後，職於 7/19 自倫敦赴布拉格，由於當日適逢微軟全球大當機，班機稍有延誤，抵達布拉格旅館入住，已經是 7/20 凌晨，稍事休息後，準備 ICP 2024 投影片，之後於 7/25 下午以口頭報告兩篇論文，分別為「Developing a Comprehensive Framework for Identifying and Evaluating Gender Bias in Chinese LLM」與「Gender Differences in Psychosocial and Physiological Responses to COVID-19 Vaccination」，報告結束後，旋即於次日整裝返國，結束本次行程。

二、 發表論文全文或摘要

本次行程共發表 3 篇論文，摘要如下:

Social Media and Gender Dynamics: Emotional Reactions to COVID-19 Vaccination

Abstract: This study aims to explore gender-specific emotional responses to COVID-19 vaccination discourse on social media in Taiwan, exploring how gender, age, and the severity of vaccine side effects interact within this context. The research intends to analyze the complex

interrelations between these variables to uncover how different demographics navigate the sentiment surrounding COVID-19 vaccination on social media. Utilizing traditional NLP and ChatGPT for emotion analysis, this study offers a unique approach to understanding the emotional dynamics at play. The research poses several pivotal questions: How do gender differences impact emotional reactions to COVID-19 vaccination discourse on Taiwan's social media? How does age influence the relationship between gender and emotion within the context of vaccination discussions? Additionally, the study explores the effect of discussions about vaccine side effects' severity on social media on the emotional responses of various demographic groups in Taiwan. By synthesizing insights on gender, age, and the portrayal of side effects, the research aims to construct a comprehensive understanding of the diverse emotional landscape surrounding COVID-19 vaccination sentiment on social media platforms. The objective is to provide actionable insights that can assist public health officials, policymakers, and communication strategists in tailoring vaccination campaigns more effectively, addressing vaccine hesitancy, and ultimately supporting the public health goal of achieving widespread immunity against COVID-19.

Gender Differences in Psychosocial and Physiological Responses to COVID-19 Vaccination

Abstract: The COVID-19 pandemic has significantly impacted the global population, revealing gender-specific variations in individual experiences and reactions. Current research suggests that women may experience more side effects and demonstrate greater hesitancy towards vaccination. However, empirical studies delving into these gender differences in vaccine responses are scarce. A key challenge lies in determining whether the side effects are purely physiological or exacerbated by psychological stress at the time of vaccination. This study provides a comprehensive analysis of gender-specific reactions to COVID-19 vaccination in Taiwan, focusing on both psychosocial and physiological aspects. Using data crawling techniques, we collected and analyzed over 1500 social media posts in Taiwan. Employing data mining methods, T-tests, and logistic regression analyses, the study uncovers significant gender disparities: women report a higher incidence of physical side effects and increased psychological emotion post-vaccination compared to men in first dose. Furthermore, it examines the mounts and severity of these side effects in women, as well as their emotional reactions. The research explores the intricate relationship between physical symptoms, emotional states, and vaccine preferences, underscoring the role of psychological factors. This study highlights the necessity for gender-sensitive public health policies. It provides essential insights for shaping vaccine policies and contributes to the field of gender psychology. By advocating for more equitable health strategies, this research addresses a critical need in public health crisis management.

Developing a Comprehensive Framework for Identifying and Evaluating Gender Bias in Chinese Large Language Models

Abstract: Large Language Models (LLMs) are increasingly indispensable across diverse domains, presenting transformative potential. However, the development of LLMs can inadvertently incorporate hidden biases, which may lead to significant societal consequences, unfair representations, and the reinforcement of stereotypes. Thus, this study introduces a framework that integrates LLM training methodologies with Structural Equation Modeling (SEM) to identify and assess gender bias in LLMs. Starting with a theoretical model firmly rooted in the existing literature on gender bias in psychology, the study seeks to predict possible manifestations and origins of bias within LLMs. Subsequently, this model undergoes empirical testing using contemporary LLMs, followed by SEM analysis to pinpoint areas where gender bias is especially pronounced. Because LLM training data and language culture are intertwined, this research has

been conducted in Traditional Chinese, specifically in the context of Taiwan. This approach is crucial in uncovering the subtle ways in which gender bias may manifest in LLM outputs and identifying the contributing factors behind it. By bridging the gap between theoretical understanding and the practical manifestations of gender bias in LLMs, our research offers critical insights into AI bias dynamics and lays the foundation for developing strategies to mitigate these biases, thereby contributing to the evolution of more equitable and unbiased AI technologies.

三、 建議

本次有機會參與兩場研討會，除有機會分享最新研究成果，並與社群媒體與心理等相關領域學者交換研究心得之外，收穫豐碩。以下為主要心得：本次 SM&S 2024 大會旨在討論社群媒體如何影響社會，今年會議共有 163 篇論文與 50 篇海報發表。會議中多位學者探討社群媒體與性別相關議題，揭示社群平台如何為性別帶來助力與來挑戰。由於本研究計畫探討性別議題，職特別摘要會議中，與性別相關的研究趨勢。

中東和北非地區的研究展示社群媒體如何挑戰性別規範，放大女性聲音，即使面臨審查和政治限制的情況下也不退縮。而有關性別暴力研究，則揭示男性對此類暴力的錯誤信念及其助長此現象正常化的態度。社群平台內容審查中的性別偏見也在另一篇研究中被深入探討，揭示審查行為如何影響性別代表性和社群參與度。此外，對 HPV 疫苗的錯誤信息研究，則呈現社群媒體上針對性別與健康問題，呈現出女性健康資訊扭曲和誤導。

另一項針對跨國酷兒文化 (Queer Cultures) 的研究，則深入探討了 LGBTQ+ 群體如何利用社群媒體抵抗傳統社會規範，並塑造出更多樣化的自我敘事。這些研究從不同角度揭示了社群媒體如何在性別平等的推動中既具挑戰也具潛力，呈現性別動態、健康錯誤以及性別文化抵關鍵角色，展示社群媒體力量和個體韌性的影響。

ICP 2024 吸引來自 96 個國家約 6000 名研究人員參加，超過 3000 篇論文發表於研討會；其中，與性別相關的關鍵趨勢包括性別平等的不同視角、性別與心理健康、性別暴力和創傷知情照護(trauma-informed care)、跨文化性別研究、制度實踐與性別等重要議題，摘要如下：關於性別平等視角，大會的專題

討論題為「多樣性、平等與包容：多學科視角的交叉視角」(Diversity, Equality & Inclusion: Intersecting Perspectives from Multidisciplinary Lenses)，由 Michal Pitoňák 主持。本議程探討跨學科合作如何促進全球對多樣性、平等和包容的理解和實踐，以發展更公平的社會。此外， Prof. Sadhana Natu 以「印度、南亞和全球北方的性別心理學」(Psychology of Gender in India, South Asia, and the Global North: Challenges and Possibilities)為主題，討論該領域的挑戰和可能。她的發言強調了在性別心理學方面建立全球團結和交流以實現共同目標的重要性。

Anushka R. Patel 博士介紹性別暴力的影響和如何普及高品質創傷知情照護(trauma-informed care)。研究重點是利用低資源社區的優勢來改善獲得護理的機會，並使用更簡短的治療設計來提高大規模採用。Natasza Kosakowska-Berezecka 博士討論全球促進性別平等的文化因素。她介紹了「邁向性別和諧」(Towards Gender Harmony)專案的研究結果，該專案分析了六大洲對男性氣質和女性氣質的當代看法，強調了跨文化研究在理解性別信仰方面的重要性。最後，關於制度實踐與性別，卡門·波林教授 (Professor Carmen Poulin's)的研究重點是正式和非正式社會制度對婦女和邊緣群體日常生活的影響。她共同創立了「公共場所心理社會人種學」（Psycho-Social Ethnography of the Common Place，P-SEC）跨學科研究小組和方法，強調制度在塑造性別經驗中的作用。ICP 2024 的這些討論強調了心理學中性別問題的多面性，強調了跨學科方法、文化敏感性和促進性別平等的機構問責制的必要性。

本次行程效益顯著。透過上述兩場國際會議平台，除發表三篇論文，展示我國於性別研究與大型語言模型之性別偏見之研究成果，同時與多位國際學者交流意見，並有機會與來自南非大學 (University of South Africa)組織與工業心理系、京都大學之學者深入交流，討論未來可行之合作，擴展我國之的國際影響力。本次會議之行收穫豐碩，除了發表論文、吸取建議外，更建立跨國合作關係，開啟未來研究合作之可能性。

四、 攜回資料名稱及內容

1. SM&S 論文全集

2. 33rd International Congress of Psychology 論文全集

六、其他

無

國家科學及技術委員會補助專題研究計畫出席國際學術會議心得報告

日期：113 年 10 月 22 日

計畫編號	NSTC－111－2629－M－492－001-MY2		
計畫名稱	女性對 COVID-19 防疫措施之認知、行為與其影響:整合巨量資料探勘、機 器學習與決策分析方法		
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	113 年 07 月 15 日至 113 年 07 月 29 日	會議地點	英國、捷克
會議名稱	1. 2024 社群媒體與社會國際研討會 International Conference on Social Media & Society 2024 2. 第三十三屆國際心理學大會 33rd International Congress of Psychology		
發表題目	1.Social Media and Gender Dynamics: Emotional Reactions to COVID-19 Vaccination 2.Gender Differences in Psychosocial and Physiological Responses to COVID-19 Vaccination 3.Developing a Comprehensive Framework for Identifying and Evaluating Gender Bias In Chinese LLMs		

一、 參加會議經過

本次行程因 職主持「女性對 COVID-19 防疫措施之認知、行為與其影響：整合巨量資料探勘、機器學習與決策分析方法」計畫，為瞭解全球最新性別研究及社群媒體相關研究之發展趨勢，與國際學術社群交流與互動，故前往出席於英國倫敦舉辦的「International Conference on Social Media & Society 2024 (SM&S

2024)」，以及捷克布拉格的第 33 屆國際心理學研討會（ICP 2024）二場會議。本次中，共發表三篇與 COVID-19 防疫措施及性別差異相關的研究論文，並參加全程會議。

本次兩場會議分別於 7/16-18 日及 7/21-26 於倫敦與布拉格舉行，為樽節國家經費，本次行程採接續移地研究後執行，節省機票費用與往返時間，此外，為擴大出席國際會議效益，本次行程共參加二場會議發表三篇論文。行程首先，於 7 月 15 日前往英國倫敦，7 月 16 日到 18 日參加 SM&S 2024 並發表研究論文，參與各場次的專題討論，深入了解全球社群媒體研究的最新趨勢與方法。7 月 19 日從倫敦前往捷克布拉格，途中於機場遭遇微軟系統大當機事件，遲滯機場數小時，抵達布拉格已隔日深夜。後於 7 月 21 日至 26 日期間參加第 33 屆國際心理學研討會（ICP 2024），並發表兩篇口頭論文。

二、 與會心得

SM&S 2024 為國際少數聚焦於 Social Media 之學術研討會，匯集資訊、傳播等跨領域學者，從不同角度聚焦 Social Media 研究各種內涵與研究方法，本人於該會議發表的論文，以 COVID-19 防疫措施為主題，探討社群媒體上的知覺與行為，與本計畫研究主題緊密相關，也了解國際對 Social Media 進行更深入的情緒分析及資訊傳播模式研究，與國內以主題熱點分析方向截然不同。ICP 2024 則是全球心理學界最具指標性的學術會議之一，自 1889 年在巴黎舉辦第一屆以來，每四年由不同洲輪流主辦，本屆會議吸引來自 96 個國家約 6000 名研究人員參加，超過 3000 篇論文發表，論文均經 Peer 審查。本人共發表兩篇口頭論文：其一於性別研究主題場次，探討不同 COVID-19 防疫措施對女性衝擊，該主題與方法受到參與者指導與支持，後續與土耳其大學學者研究建立合作並交換論文，持續深入討論；其二則為大型語言模型（LLM）中的性別偏見實驗研究，此研究受京都大學研究者高度興趣，同時已確定實際合作關係。

三、 發表論文全文或摘要

本次行程共發表 3 篇論文，本人皆為第一作者，摘要如下:

Social Media and Gender Dynamics: Emotional Reactions to COVID-19 Vaccination

Abstract: This study aims to explore gender-specific emotional responses to COVID-19 vaccination discourse on social media in Taiwan, exploring how gender, age, and the severity of vaccine side effects interact within this context. The research intends to analyze the complex interrelations between these variables to uncover how different demographics navigate the sentiment surrounding COVID-19 vaccination on social media. Utilizing traditional NLP and ChatGPT for emotion analysis, this study offers a unique approach to understanding the emotional dynamics at play. The research poses several pivotal questions: How do gender differences impact emotional reactions to COVID-19 vaccination discourse on Taiwan's social media? How does age influence the relationship between gender and emotion within the context of vaccination discussions? Additionally, the study explores the effect of discussions about vaccine side effects' severity on social media on the emotional responses of various demographic groups in Taiwan. By synthesizing insights on gender, age, and the portrayal of side effects, the research aims to construct a comprehensive understanding of the diverse emotional landscape surrounding COVID-19 vaccination sentiment on social media platforms. The objective is to provide actionable insights that can assist public health officials, policymakers, and communication strategists in tailoring vaccination campaigns more effectively, addressing vaccine hesitancy, and ultimately supporting the public health goal of achieving widespread immunity against COVID-19.

Gender Differences in Psychosocial and Physiological Responses to COVID-19 Vaccination

Abstract: The COVID-19 pandemic has significantly impacted the global population, revealing gender-specific variations in individual experiences and reactions. Current research suggests that women may experience more side effects and demonstrate greater hesitancy towards vaccination. However, empirical studies delving into these gender differences in vaccine responses are scarce. A key challenge lies in determining whether the side effects are purely physiological or exacerbated by psychological stress at the time of vaccination. This study provides a comprehensive analysis of gender-specific reactions to COVID-19 vaccination in Taiwan, focusing on both psychosocial and physiological aspects. Using data crawling techniques, we collected and analyzed over 1500 social media posts in Taiwan. Employing data mining methods, T-tests, and logistic regression analyses, the study uncovers significant gender disparities: women report a higher incidence of physical side effects and increased psychological emotion post-vaccination compared to men in first dose. Furthermore, it examines the mounts and severity of these side effects in women, as well as their emotional reactions. The research explores the intricate relationship between physical symptoms, emotional states, and vaccine preferences, underscoring the role of psychological factors. This study highlights the necessity for gender-sensitive public health policies. It provides essential insights for shaping vaccine policies and contributes to the field of gender psychology. By advocating for more equitable health strategies, this research addresses a critical need in public health crisis management.

Developing a Comprehensive Framework for Identifying and Evaluating Gender Bias in Chinese Large Language Models

Abstract: Large Language Models (LLMs) are increasingly indispensable across diverse domains, presenting transformative potential. However, the development of LLMs can inadvertently incorporate hidden biases, which may lead to significant societal consequences, unfair

representations, and the reinforcement of stereotypes. Thus, this study introduces a framework that integrates LLM training methodologies with Structural Equation Modeling (SEM) to identify and assess gender bias in LLMs. Starting with a theoretical model firmly rooted in the existing literature on gender bias in psychology, the study seeks to predict possible manifestations and origins of bias within LLMs. Subsequently, this model undergoes empirical testing using contemporary LLMs, followed by SEM analysis to pinpoint areas where gender bias is especially pronounced. Because LLM training data and language culture are intertwined, this research has been conducted in Traditional Chinese, specifically in the context of Taiwan. This approach is crucial in uncovering the subtle ways in which gender bias may manifest in LLM outputs and identifying the contributing factors behind it. By bridging the gap between theoretical understanding and the practical manifestations of gender bias in LLMs, our research offers critical insights into AI bias dynamics and lays the foundation for developing strategies to mitigate these biases, thereby contributing to the evolution of more equitable and unbiased AI technologies.

四、 建議

SM&S 2024 會議中與各國研究者交流社群媒體如何打破傳統性別角色，並討論社群媒體中普遍存在各國之性別偏見問題，職於會議發表論文採用之資料探勘技術，吸引諸多學者興趣與交流，認為 Computational Social Science 將是未來社會領域重點方法之一，建議台灣應及早投入發展。在 ICP 2024 中，性別研究為本次大會主要議程之一，南美洲、歐洲不同國家學者各由其文化背景進行研究，包含性暴力、低薪等議題，從中職了解到性別研究議題不僅涉及心理層面，還涵蓋經濟體系、教育、薪資差異等多個層面，也發現許多國家認知到性別議題對人類社會具有深遠影響且願意投入，而本次發表 COVID-19 疫苗之性別態度差異，也吸引土耳其大學、京都大學興趣，後續已建立具體合作關係，展開跨國分析研究，台灣研究也受到肯定，職於本次行程收穫豐盛。

唯在二場會議中，發現性別研究的挑戰在於參與者群體大多數以女性為主，討論容易陷入同溫層。性別議題需要多元性別的參與，才能促進更多元化的視角和解決方案。此外，本次出席國際研討會，也意識到台灣在國際學術研究的參與度上，與韓國、日本等相有明顯差距。無論是參與者數量還是發表論文的頻率，台灣在這些指標上還有進步空間。

五、 攜回資料名稱及內容

1. SM&S 論文全集

2. 33rd International Congress of Psychology 論文全集

六、其他

無