

**The concepts of sustainability value and the application of big data
in enhancing the ability of sustainability marketing**

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The concepts of sustainability value and the application of big data in enhancing the ability of sustainability marketing

Purpose –We seek to contribute to the literature by comparing and analyzing the relationship between Australian and Taiwanese students regarding environmental value attitude, action intention and green marketing intention. Specifically, by comparing the green marketing intention of hospitality and tourism (H&T) students in the East with that in the West.

Design/methodology/approach –A well-designed curriculum examines student thinking and behavior (learn). This study compares and analyzes the value and attitude and the application of big data to green marketing among Taiwanese and Australian university students using the stimulus-organism-response (S-O-R) model. Structural equation modelling (SEM) was used to test the hypotheses in a sample of 633 H&T students in Taiwan (389) and Australia (244).

Findings –This study also shows how the national differences between Australia and Taiwan have interference effects on the relationship between value attitudes and action intentions and between action intentions and the green marketing intention. We also combined the application of big data and related variables and estimated the mediating effect of related variables to evaluate the impact on action intentions and green marketing of big data applications.

Practical implications – There are significant differences in the sustainable behavior and intentions of H&T higher education students that reflect the educational differences between the East and the West. With the strengthening of environmental action intention (AI) and green marketing intention (GMI), Taiwanese hospitality and management (H&M) students' sense of crisis increases, and their performance in GMI is slightly higher than that in Australia.

Originality/value – These findings indicate that it is necessary to consider students' ecological concepts, environmental knowledge, environmental value attitude and environmental action intention to improve their intentions to engage in green marketing under the stimulus-organism-response (S-O-R) framework. We also found that environmental knowledge has a mediating

effect on the relationship between ecological concepts and environmental value attitude.

Keywords: Stimulus-organism-response theory; ecological concept; sustainability value attitude; application of big data; sustainability marketing ability

1. Introduction

The tourism and hospitality industries often rely on rich and diverse environmental resources. However, overexploitation and environmental damage will threaten this natural and cultural resource and cause irreversible damage to the local ecosystem. Tourism and hospitality education needs to cultivate more professionals to ensure the sustainable development of this industry and have a positive impact on the local community (Horng et al., 2022). Their stance

reinforces the significance of integrating advanced data analytics into the industry's operational framework, emphasizing the potential of big data to revolutionize the way sustainability is perceived and pursued within the H&T sector. To this end, the “stimulus–organism–response” (S-O-R) framework helps to clarify the relationship between current H&T students' perceptions, attitudes and behavioral intentions as related to sustainability (Wang et al., 2020).

Australia's unique geographical location contains many ancient and important animal and plant species that constitute excellent tourism resources for its multibillion-dollar tourism sector. Likewise, the Taiwanese government and education sector have actively promoted sustainability in their curriculum in recent years (Horng et al., 2022). Given its leading information and communication technology (ICT) industry and world-class IT network infrastructure, Taiwan presents a valuable context for investigating the correlation between big data and the advancement of sustainable practices, not limited to the environmental aspect (Horng et al., 2022). This includes aspects such as social, economic, and cultural dimensions of sustainability, which are integral to comprehending the broader implications of sustainable development within the region (Huang et al., 2014). The exploration of this relationship in the Taiwanese context allows for insights into how big data can contribute to holistic sustainability strategies that encompass various dimensions beyond the conventional environmental realm (Wu et al., 2021).

This study addresses research gaps and significant issues for specific reasons. First, the H&T industry can benefit from insights into ecological concepts, sustainability knowledge, value attitudes, action intentions, and marketing abilities among H&T students (Chou et al., 2019; Horng et al., 2022). In the era of extensive social media use, individuals generate vast personal data through interactions with social media platforms. However, research gaps persist in explorations of the relationships among sustainability knowledge, value attitudes, action intentions, and big data application in terms of marketing analysis skills and employability among H&T students. Thus, this study aims to address these gaps and provide a comprehensive

understanding of these interconnected factors. Second, the relevance of this study in the context of the COVID-19 pandemic is significant. The pandemic has led to increased online consumption of various H&T products and services due to social distancing measures and lockdown policies (Cho, Joo, & Koh, 2022). This study reveals that personalization can enhance students' engagement with big data applications, which influences their intention to engage in sustainable actions and marketing efforts. Further, despite these findings, a research gap exists in understanding the connection between personalization, big data application, and the impact of these factors on students' behavioral intentions within sustainable action and marketing contexts. Finally, this study aims to provide contributions by conducting a comparative analysis of Australian and Taiwanese students regarding sustainability value attitudes, action intentions, and marketing abilities. By examining these student groups cross-culturally, this study seeks to understand how cultural backgrounds influence students' behavioral intentions toward sustainability and marketing.

2. Literature review

2.1. The stimulus-organism-response (S-O-R) research method

The stimulus-organism-response (S-O-R) model provides a useful theoretical framework for this study. The S-O-R model refers to environmental stimulus (S) leading to an emotional organism (O), which promotes a behavioral response (R). Many consumer studies have widely used S-O-R theory to confirm the relationship between environmental stimuli and consumers' willingness to repurchase (Joshi & Rahman, 2019). Various topics of studies that use the S-O-R model include restaurant operators' application of big data related to sustainability marketing, and students' online learning performance (Chou et al., 2019). Therefore, the S-O-R model can be used to explain the relationship among H&T students' value and attitude, environmental action, and green marketing intention, as well as the way in which the relationship between big

data and other new technologies affects green marketing. Stimulus refers to the attributes (such as ecological concepts and environmental knowledge) that affect students' value and attitude (Organism) and their status regarding environmental action and green marketing intention in the H&T sustainable education environment. A value and attitude that is influenced by stimuli will eventually lead to a sustainable behavior intention response (e.g., environmental action and green marketing behavior intention).

To this effect, this study combines the application of big data, of which Stimulus is perceived as big data awareness and risk, which affects data personalization and the organization of big data application, its environmental action, and its green marketing. Stimulus is also the mechanism by which intention generates response. By exploring the integration of big data application concepts into green marketing and applying the S-O-R theory, this study expands the literature on education and marketing in Eastern and Western hospitality-comparison studies in environmental cognition, attitudes, and actions (Leung et al., 2013).

2.2. Ecological concept and sustainability knowledge

The increased consciousness about the significance of upholding sustainable practices has expedited the worldwide recognition of the need to enhance education centered around sustainability within the H&T industry (Liu et al., 2017). This encompasses a broader spectrum beyond merely environmental concerns. This enhanced awareness has triggered a more holistic understanding of sustainable practices that extend beyond the conventional environmental context. Environmental-related information needs to be more actively integrated into the concept of environmental protection; thus, this will lead to a higher level of knowledge about environmental protection and ecologically sustainable development. Furthermore, Hu et al. (2012) emphasized that individuals who prioritize the tenets of sustainability are inclined to

proactively seek information related to sustainable practices. As a result, customers tend to possess a deeper comprehension of measures aimed at fostering ecological balance and sustainable progress (Wang et al., 2020). Additionally, students in the field of hospitality and tourism (H&T) who exhibit an elevated degree of awareness about sustainability tend to display heightened self-assurance (Horng et al., 2022). This heightened self-assurance is coupled with a positive disposition toward innovatively crafting tours and experiential activities that harmonize more effectively with the requisites of sustainable practices, without explicitly invoking the term "environmental." This indicates their capability to envision novel methods to engage in activities that promote the overall well-being of their surroundings, encapsulating the principles of sustainability while maintaining a broader focus beyond just the environment (Shimul & Cheah, 2023). Based on the above, the hypothesis of this study is as follows:

H1. Environmental knowledge has a mediating effect on the relationship between ecological concepts and values and attitudes.

2.3. Value and attitude

In S-O-R model theory, values and attitudes usually play an intermediary role in the relationship between persistent cognition and behavioral intention (Han, Hampson, Wang, & Wang, 2022; Wu et al., 2021). The concept of sustainability value attitude encapsulates an individual's conviction in the obligation to partake in ecologically conscious consumption or to endorse actions geared toward fostering a greener and more sustainable approach to sightseeing or dining (Horng et al., 2022). This pertains to an individual's recognition of the significance of incorporating eco-friendly practices and promoting responsible behavior without explicitly referencing the environment (Shimul & Cheah, 2023). In essence, it reflects a person's inclination toward choices and behaviors that contribute to the overall betterment of the surroundings in which they interact, be it through conscious consumption or supporting initiatives that align with sustainability objectives (Zameer & Yasmeen, 2022). This

underscores the notion that individuals' ethical and moral considerations regarding ecological aspects significantly influence the new generation's inclination toward green purchase decisions (Prasad et al., 2019). This could also be confirmed by green hotel consumption behavior research (Teng et al., 2018). Wu et al. (2021) also pointed out in their research that the value attitude of H&T students has a mediating effect on the relationship between personal knowledge motivation and experience outcomes. Based on the above, we propose H2 as follows:

H2. Value and attitude have a mediating effect on the relationship between environmental knowledge and action intention.

2.4. Action intention

Value attitude refers to an individual's belief in the responsibility of participating in green consumption or supporting environmental protection actions in sightseeing or catering, such as the individual's belief that sustainable products should be purchased frequently, the willingness to accept additional payments to support sustainable tourism, and the willingness to participate in low-carbon emission tourism, which stimulates personal environmental protection action intentions in tourism and hospitality through value attitudes (Horng et al., 2022). In accordance with the S-O-R (stimulus–organism–response) model, the concept of action intent denotes an individual's behavioral response (organism) to stimuli (stimulus). In this context, sustainability action intent pertains to an individual's inclination to initiate and promote activities that support sustainability (Panda et al., 2020). A favorable attitude toward sustainability is likely to motivate individuals to actively participate in behaviors aligned with sustainability values, as they recognize the importance of promoting environmentally friendly practices and advocating for sustainable innovation (Zameer & Yasmeen, 2022). Subsequently, as individuals actively participate in sustainable behaviors, they gain firsthand knowledge, skills, and insights into

effectively promoting and advocating for sustainability-related initiatives (Shimul & Cheah, 2023). This knowledge translates into their ability to proficiently communicate the value of sustainability to various stakeholders, including peers, customers, and the community at large (Panda et al., 2020).

In an empirical study on entrepreneurs, Horng et al. (2022) further pointed out that the application of big data plays a mediating role on the relationship between the self-efficacy and behavioral intention of tourism and hotel students and the self-efficacy and application within the industry. As de Bernardi (2022) points out, the clearer the information about tourism data is, the more informed students are about tourism-related data and information so that they can analyze, apply, criticize, and develop improved solutions, thereby ensuring a more ethical future for tourism systems. Therefore, this study infers that the higher efficacy of big data will encourage hospitality and tourism students to have a higher intention of sustainable environmental protection action. Based on the above, we propose Hypotheses H3a and H3b as follows:

H3a. Action intention has a mediating effect on the relationship between value attitude and green marketing intention.

H3b. Action intention has a mediating effect on the relationship between the application of big data and green marketing intention.

2.5. Perceived big data awareness and risk

Personalization is defined as the degree to which individuals agree that Big Data can formulate personalized services and provide advertising information suitable for consumers in real time. Such positive attitudes will vary with individuals' understanding or trust in Big Data, and higher perceived big data awareness (PBDA) will make individuals more willing to accept the application of big data (ABD) through personalization (PER) (Shahbaz et al., 2020). In

addition, individuals have a deeper understanding of the concepts and applications of big data, and they are more likely to accept and be willing to apply the technology. The perception of big data technology also involves individuals' perceptions of its trust and security (Malhotra et al., 2004). If individuals believe that the use of big data is transparent and legal, they are more inclined to accept and use related technologies (Chou et al., 2019).

In addition, perceived big data risk entails an understanding that providing personal information to companies for big data use is risky and may cause significant losses and great uncertainty (Malhotra et al., 2004). Therefore, it is necessary to understand customers' perceived big data awareness and risk. Xu et al. (2009) pointed out in a study related to big data that customers expect and fear being hurt by their location-based services (LSB), and that providing push services is more important than providing pull services. This means that personalization may have a mediating effect in the process of big data application. For example, the higher the user's perceived big data awareness and risk and personalization is, the more positive their attitude toward the application of big data may be (Malhotra et al., 2004; Shahbaz, Gao, Zhai, Shahzad, Abbas, & Zahid, 2020). Based on the above, we propose H4a and H4b hypotheses as follows:

H4a. Personalization has a mediation effect on the relationship between perceived big data awareness and the application of big data.

H4b. Personalization has a mediation effect on the relationship between perceived big data risk and the application of big data.

2.6 Application of big data

Big data analysis is considered to help collect, analyze, and interpret very large amounts of environmental monitoring data, including information on climate change and environmental pollution. Such monitoring and analysis can provide valuable information that helps individuals

better understand environmental conditions and detect problems early; the stronger the sense of identification is, the higher the individual's environmental action intention (AI) (Liu et al., 2023). Additionally, personalization services not only minimize wastage but also enable environmentally sustainable market targeting, aligning with the principles of sustainable development (Horng et al., 2022). However, when individuals are presented with incentives for their participation in big data processes, the adoption of big data becomes more palatable (Xu et al., 2009). To elaborate further, big data's capability to gather and analyze copious amounts of individual-level data permits a more nuanced grasp of consumers' unique inclinations and sustainable behaviors (Kautish, Khare, & Sharma, 2020). This, in turn, facilitates the creation of tailored marketing strategies that resonate with consumers on a personal level (Wang et al., 2020). Moreover, by delivering targeted sustainability information to consumers based on their preferences and behaviors, big data contributes to a more efficient allocation of resources, reducing unnecessary promotional efforts and minimizing the generation of excess materials (Kautish et al., 2020). Consequently, the mediating effect of big data application between personalization and sustainability action intent comes to light. This inference is supported by the proposition that big data serves as a conduit for the transformation of personalized insights into actionable intentions for sustainable behaviors. Thus, H5 is formulated as follows:

H5. The application of big data has a mediation effect on the relationship between personalization and action intention.

2.7. Green marketing Intention

Related research on sustainable action shows that sustainability action intention is the behavioral intention generated after personal cognition is strengthened by sustainability attitude, including an individual's willingness to encourage others to engage in sustainable H&T-related activities and sustainable marketing environmental actions (Horng et al., 2022). Chou et al.

(2019) also pointed out from relevant evidence that the application of big data can help improve the sustainability marketing performance of catering companies. In a study by Liu et al. (2017), it is mentioned that for H&T students to benefit from sustainable education, there should be more creative courses aimed at changing students' cognition, attitude, and behavior toward sustainability.

However, from past research such as Leung et al. (2013) used 21 American universities and 18 Chinese universities to conduct a comparative survey of hospitality courses and found that students from different cultures have significantly different performances in hospitality courses, suggesting that more comparative research should be done. Regarding sustainability and employability, different countries, such as the United Kingdom, Switzerland, and the United Arab Emirates, have differing levels of enthusiasm for sustainable action activities. Swiss students have a more positive attitude and higher employability (Ali, Murphy, & Nadkarni, 2014). Compared to Australia's emphasis on H&T sustainable development teaching, Chinese H&T education is relatively less flexible and outmoded in terms of teaching materials and teaching methods (Wang et al., 2020). However, in recent years, with the application of big data and more sustainable innovation courses to the teaching of Taiwanese H&T students, sustainable intention and sustainability marketing ability has been significantly improved (Horng et al., 2022). Therefore, we propose H6a and H6b hypotheses as follows:

H6a. The category of country has a moderating effect on the relationship between sustainability attitude and sustainability marketing intention.

H6b. The category of country has a moderating effect on the relationship between sustainability intention and sustainability marketing intention.

3. Research method

3.1 Research Framework

Based on the S-O-R model, this study aims to examine the relationships among knowledge, attitude, behavioral, marketing ability in sustainability and perceptions and applications of big data and further compares the model differences between the universities of hospitality and tourism (H&T) students from Taiwan and Australia. The research framework is developed and illustrated in Figure 1. Why did this study use the S-O-R model as our theoretical foundation? The main reason lies in the S-O-R model, which indicates that certain environmental stimuli influence consumers' internal state or organism and shape their behavior (Kumar, 2016). In particular, the S-O-R model is applicable to both S-O and O-R stages (Vieira, 2013). In Figure 1, "S" refers to an arousing influence that can motivate and influence students' choice and participation in ecological education as well as the concept of big data. "O" refers to the students' perception, affection and attitude, including the entire process of intervening between the stimulus and response in ecological education as well as the concept of big data. "R" refers to the consequences of students' participation in ecological education as well as the application of big data. It reflects the students' behavior toward sustainability actions and marketing via ecological education and big data application.

~insert Figure 1 here~

3.2 Measurement of variables

We use a seven-point Likert scale to measure the constructs. First, EC, VA and AI are all single-dimensional constructs with 3 items, 3 items, and 2 items, respectively. These three constructs are modified from Chou et al. (2019) and Horng et al. (2022). Second, KN is also modified from Patwary et al. (2022) and is a 3-item construct. Third, PBDA is modified from Malhotra et al. (2004) and is a single construct with 3 items. Fourth, PRDR is a single-dimensional construct with 3 items that is modified from Malhotra et al. (2004). Fifth, PER is a 3-item construct and is modified from Shahbaz et al. (2020) and Xu et al. (2009). Next, ABD

and GMI construct modified from Chou et al. (2019).

3.3 Sampling

Prior to the sampling phase, the Taiwan research team first proposed research cooperation needs to the Australian Cooperation University in November 2020 and submitted a questionnaire survey application to the school in February 2021 to explain the purpose of the research and the content of the questionnaire. After removing sensitive items such as work experience and allowing respondents to opt out of answering items such as gender and any sensitive information, the questionnaire survey was planned after passing the ethics application process review in June 2021. Due to the survey time being affected by the COVID-19 epidemic, this study then mainly distributed online questionnaires, designed questionnaires through Google forms, and recruited volunteers to participate in classrooms and online social media channels by school teachers. To confirm the participants' recognition of the questionnaires and objectives of this study, the prediction survey used 100 questionnaires collected by juniors and seniors at a university in northern Taiwan. This confirmed that the respondents could understand the semantics of the questionnaire items and the content of related topics. Next, the questionnaire was collected for a total of three months from July 1, 2021, to September 30, 2021. Finally, since those who did not complete the questionnaire could not submit the online questionnaire, there were no incomplete or missing values. A total of 633 opinions were collected, among which 389 from Taiwan and 244 from Australia participated in the research survey.

~insert Table 1 here~

4. Results and analyses

4.1 Analysis of the sample structure

In the analysis of the proposed research model, AMOS 24 software was used to conduct structural equation modeling (SEM) on a sample comprising 389 volunteers from Taiwan and 245 volunteers from Australia who assisted in completing the questionnaire. These volunteers played a crucial role in the research process by providing assistance in questionnaire completion, which was essential for data collection. A total of 633 valid questionnaires were recovered (the effective response rate was 100%). Based on the 633 valid samples, the analysis of the demographic variables is shown in Table 1. According to Table 1, we found the following: (1) The gender of most respondents in the two samples is female; (2) The average age (52.7%) in Taiwan is 15-20 years old and (78.7%) in Australia is 21-30 years old; (3) The current school year of the students used in the study is that of a junior (27.8%) in Taiwan and that of a senior (33.6%) in Australia senior. As for the sample mean analysis, the means of the variables in this study are EC (5.46), KN (5.25), VA (5.27), AI (5.35), PBDA (5.35), PBDR (5.08), PER (5.25), ABD (5.21) and ASM (5.50). PBDR is the smallest among them, while ASM and EC are the largest. In short, EC has been a universal value worldwide, and students' intention of sustainability marketing is also at a high level, but the level of PBDR of these students seems relatively low. This study used the Kolmogorov–Smirnov and Mann–Whitney U tests to examine population normality. Unfortunately, the statistical results indicated that the normality test failed. The reason possibly results from the cross-cultural impact. The approaches for dealing with nonnormality will be addressed in Chapter 5 under the section on “Limitations and future works”.

4.2 Confirmatory factor analysis (CFA)

After the CFA stage, the indices of our model fit are GFI=0.93, CFI=0.99, NNFI=0.99, SRMR=0.032, RMSEA=0.040, and Normed Chi-square= 2.03. From these pieces of evidence, we conclude that the fit of this model is reasonably acceptable. Therefore, the model fit gives

us the confidence to examine the hypothesis.

4.3 Reliability and validity

In this study, the Cronbach's α value of the 12 dimensions ranged from 0.74 to 0.91 (see Table 2). Meanwhile, all the t values of each construct are significant (t values range from 14.53 to 25.40), indicating that this model's convergent validity is acceptable (see Tables 3 and 4).

~insert Table 2-4 here~

4.4 Correlation analysis

As summarized in Table 4, the results show that all the correlations between factors are significant. Furthermore, all the constructs' correlations are almost less than the average variance extracted (AVE), demonstrating significant discriminant validity between the structures.

4.5 Structural model and hypothesis testing

This study sheds light on the intricate connections among EC, EK, VA, AI and ASM as well as PDBA, PDBR, PER and ABD in hospitality and tourism students from Taiwan and Australia (see Figure 3 & Figure 4, Table 6 & Table 7). The empirical findings lead to several key discussions. As shown in Figure 2, the path coefficients EC \rightarrow EK ($\beta=0.67$, $p<0.001$) and EK \rightarrow VA ($\beta=0.76$, $p<0.001$) are both significant. This first supports H1, emphasizing the key role of EK in shaping both EC and VA. This highlights that possessing greater knowledge about environmental sustainability strengthens students' conviction regarding their obligations to engage in ecologically conscious behaviors and make sustainable choices. The mediating effect suggests that nurturing students' sustainability knowledge is pivotal in cultivating positive attitudes aligned with sustainable values. EK acts as the foundational basis for individuals to

understand environmental issues (DeCecco, 1968), influencing the formation of VA in the environment (Teng et al., 2018; Lopez, 2020; Liu et al., 2020). Therefore, integrating EK into the university education process, which includes curriculum design, student engagement, personal ecological understanding, and the establishment of values, is a fundamental requirement.

Moreover, the knowledge-attitude-practice (KAP) model has recently been applied in environmental management (Wang et al., 2020). As shown in Figure 2, the path coefficients EK → VA ($\beta=0.76$, $p<0.001$) and VA → AI ($\beta=0.75$, $p<0.001$) are both significant, confirming that VA plays a crucial role in transforming EK into AI. This reveals that favorable attitudes toward sustainability principles motivate students to actively participate in eco-friendly initiatives. The emphasis of this mediation is on the importance of translating positive sustainable outlooks into tangible actions. This finding aligns with prior research supporting the KAP model, emphasizing the intermediary role of attitudes in translating knowledge into practical engagement (e.g., Kumar, 2016; Wu et al., 2021). To effectively convert attitudes into actions, universities can highlight the link between educational goals and real-world actions by employing measures such as providing tools, encouraging participation, offering guidance, and fostering a supportive environment. These factors collectively encourage students to turn attitudes and values into active engagement and contribution.

Additionally, the study validates the mediating role of AI in the relationship between VA and ASM, as well as between ABD and ASM. As shown in Table 6, the total effects of VA → AI → ASM ($\beta=0.74$, $p<0.001$) and ABD → AI → ASM ($\beta=0.28$, $p<0.001$) were significant. This finding suggests that AI plays a key mediating role in the positive influence of VA and ABD on students' ASM. In other words, favorable VA and increased ABD do not directly enhance ASM but rather operate by enhancing students' AI first. As depicted in Figure 2, all the path coefficients were significant, aligning with the theoretical reasoning that greater AI stemming from positive VA and ABD leads to boosted ASM. These findings align with previous research

(Panda et al., 2020; de Bernardi, 2022), emphasizing the importance of fostering positive VA and leveraging ABD effectively in managerial practices. Notably, attitudes, as highlighted by Ferdous (2010), can influence the intention for sustainable marketing, and ABD facilitates informational access for improved marketing performance (Gupta et al., 2021). In summary, university education should prioritize nurturing students' VA and AI, incorporating modern technologies such as big data. This is crucial for enhancing overall ASM and cultivating socially responsible, innovative marketing professionals.

Overall, the adoption of personalized methodologies in big data analytics plays a crucial role in improving operational management by effectively accommodating individual variations, enhancing application flexibility, and refining precision. However, it is imperative to simultaneously address privacy and security concerns to ensure the lawful and secure use of individual data. The mediating effects of PER, as indicated by H4a and H4b, underscore its effectiveness in alleviating privacy and ethical concerns associated with big data adoption (Xu et al., 2009). Table 5 shows that the total effects of PBDA->PER->ABD ($\beta=0.69$, $p<0.001$) and PBDR->PER->ABD ($\beta=0.16$, $p<0.001$) were significant, indicating that PER plays a key role in transmitting the influence of PBDA and PBDR into students' ABD. PBDA and PBDR do not directly shape ABD but rather operate through PER first. As shown in Figure 2, all the path coefficients were significant, supporting the reasoning that heightened PER stemming from greater PBDA and PBDR contributes to increased ABD. Personalized services enhance the effectiveness of students' engagement with ABD. This finding is consistent with that of Shahbaz et al. (2020), who suggested that engaging in transparent communication and highlighting the potential for personalization could persuade cautious students to embrace big data. In adapting to societal and technological changes, university education should focus on personalization. This includes providing flexible interdisciplinary courses, personalized digital instruction, and tailored internships based on individual career goals. Through the comprehensive integration of PER in education, universities can better cultivate students with deep knowledge, diverse

skills, and unique qualities, enabling them to confidently face the challenges of the future society.

Big data contributes to sustainable consumption by enhancing consumer experiences, predicting buying patterns, and transforming business models (Chandra & Verma, 2021). As shown in Figure 2, the path coefficients PER → ABD ($\beta=0.77$, $p<0.001$) and ABD → AI ($\beta=0.52$, $p<0.001$) are both significant (H5 supported), revealing that the mediating effect of ABD plays a vital role in channeling personalized insights toward shaping AI aligned with ASM (Chou et al. 2019). This suggests that ABD plays a crucial mediating role in the positive influence of PER on students' AI. In other words, PER does not directly enhance AI but requires the intermediary effect of ABD. This finding also underscores those personalized insights garnered from big data analysis can effectively be transformed into actionable sustainable practices when students recognize the value of partaking in environmentally conscious activities. Additionally, to ensure the robustness of the findings, this study divides the original sample into two groups, Taiwan and Australia, and follows the previous procedure to perform individual path analysis and gauge the total effect (see Figure 3 & Figure 4, Table 6 & Table 7). According to the evidence in these figures and tables, these path coefficients and the total effects of the subsamples are significant, which supports the original proposed research model. Therefore, according to the results, to address the impact of big data on sustainable consumption, universities should equip students with the skills to navigate this complex issue, including integrating courses on applying big data for enhanced consumer experiences, predictive buying patterns, and transformative business models. Clearly, students need data analysis skills for sustainable marketing. In addition, encouraging interdisciplinary learning and providing practical opportunities, such as internships, would prepare students to address business challenges and implement sustainable consumption practices.

~insert Figure 2-4 here~

~insert Table 5-7 here~

4.6 Moderating effects

In this section, we will examine the moderating effect of TYPE (i.e., *Taiwan=0*, *Australia=1*) on three paths (i.e., AI-ISM, ABD-AI & VA-AI) by using Model 1 of the Hayes' PROCESS macro for SPSS (5000 bootstrapping).

AI-ISM: First, we find that the coefficient of the interaction item (AI*TYPE) is -0.105 ($p < 0.05$), meaning that TYPE has a moderating effect on the relationship between AI-ISM. Next, we plot two regression equation effects of TYPE, for example, for Taiwan (TYPE=0), $Y = 2.468 + 0.590X$, and for Australia (TYPE=1), $Y = 2.786 + 0.483X$. From Figure 5, it can be seen that TYPE moderates the relationship between AI and ISM such that the ASM of Australian students is weaker than that of Taiwanese students when the level of AI is high.

~insert Figure 5 here~

ABD-AI: Since the coefficient of the interaction item (ABD*TYPE) is 0.071 ($p > 0.05$), there is no moderating effect of TYPE on the relationship between ABD-AI.

VA-AI: First, we find that the coefficient of the interaction item (VA*TYPE) is -0.120 ($p < 0.05$), meaning that there is a moderating effect of TYPE on the VA-AI relationship. Next, we plot two regression equation effects of TYPE, for example, for Taiwan (TYPE=0), $Y = 1.035 + 0.824X$, and for Australia (TYPE=1), $Y = 1.629 + 0.704X$. According to Figure 6, TYPE moderates the relationship between VA and AI such that the AI of Australian students is weaker than that of Taiwanese students when the level of VA is high. Leung et al. (2013) asserted that the moderating effect of country categories can give rise to cross-cultural variations in behavioral responses. In this study, the category of country (CC) moderates the association between VA and AI (H6a supported), such that this relationship is weaker for Australian students than for Taiwanese students when VA levels are high. A potential

explanation is that Australian students' elevated individualism dampens the translation of strong sustainable values into actual behaviors, contrasting with Taiwanese students' collectivist cultural context. Additionally, CC moderates the link between AI and ASM (H6b supported), with Australian students displaying weaker sustainability marketing skills than Taiwanese students when AI is high. This variation likely stems from the relative lack of emphasis on sustainability in Australian H&T education compared to Taiwan, where a focus on this topic is fostered by the country's leading ICT and big data infrastructure. In summary, the comparative analysis between Australian and Taiwanese students sheds light on how cultural and educational differences shape sustainability attitudes and competencies. The findings provide valuable insights to guide strategies for enhancing sustainability education across diverse contexts.

~insert Figure 6 here~

5. Discussion

This study aims to offer a more comprehensive understanding of the relationships among big data applications, sustainability value attitudes, and potential behavior development. Furthermore, this study employs the S-O-R theory to elucidate the relationships among ecological concepts, sustainability knowledge, attitude, action intention, and the sustainability marketing ability of H&T university students. Various perspectives on knowledge, value attitudes, sustainability action intention, personalization, and big data applications highlight the effects of mediating variables and related factors. Additionally, a comparison of the performance of H&T students in Australia and Taiwan in terms of sustainability action intention and sustainability marketing reveals that the country of origin moderates the relationship between value attitudes and sustainable action intention, as well as between sustainable action

intention and sustainable marketing. In summary, this study's comprehensive examination of interconnected variables related to sustainability cognition, attitude, intention, and behavior offers a more nuanced and holistic perspective compared to past single-variable analyses. The proposed research model serves as a robust framework for advancing theoretical discussions on the efficacy of sustainability education and big data applications. Based on the research findings, this study has the following theoretical and practical implications.

5.1. Theoretical implication

The results of this study reveal several significant theoretical implications. First, the study emphasizes the importance of integrating students' ecological concept (EC), environmental knowledge (EK), value and attitude (VA), and action intention (AI) within the S-O-R framework to enhance their proficiency in sustainability marketing. This builds upon Horng et al.'s (2022) research and contributes value to the literature. Additionally, the study demonstrates that EK plays a mediating role in connecting EC with VA, suggesting that enhancing students' EK can lead to a stronger manifestation of VA, which is particularly beneficial for educational institutions (Joshi & Rahman, 2019; Teng et al., 2018).

Second, the analysis reveals that VA acts as a mediator in the relationship between EK and AI. This observation aligns with studies by Han et al. (2022) suggesting that VA prompts individuals to support sustainable actions in the hospitality and tourism (H&T) sector. Within the S-O-R framework, the study demonstrates that AI functions as a mediator between VA and the enhancement of action sustainability marketing (ASM) (Kumar, 2016). Furthermore, this study addresses the gaps identified by Ferdous (2010) regarding the influence of sustainable innovation attitudes on the effectiveness of sustainability marketing among restaurateurs.

Moreover, the study explores the mediating effect related to the application of big data. Primarily, personalization (PER) mediates the association between big data awareness (PDBA)

and the application of big data (ABD), shaping awareness and risk perceptions (Gupta et al., 2021). This finding resonates with Xu et al.'s (2009) observations on the dual nature of big data utilization and privacy concerns. It expands upon previous research by focusing on H&T students, filling gaps in the literature that primarily used customers or tourists as samples. This study thoroughly examines AI, revealing its complex interplay with ASM and variables related to ABD through empirical evidence and the literature (Wang et al., 2020). The incorporation of country as a moderator for analysis highlights disparities in sustainable behaviors and competencies among H&T higher education students in Australia and Taiwan, underscoring the educational distinctions between the two regions. These diverse outcomes may be influenced by Taiwan's limited natural resources and its smaller size, which may lead to differences in AI and ASM performance among Taiwanese H&M students compared to their Australian counterparts.

5.2. Practical implications

In this study, the variables of value and attitude (VA), personalization (PER), and application of big data (ABD) play pivotal roles. First, an increase in environmental knowledge (EK) can positively influence attitudes toward sustainable values. By incorporating environmental protection information and labels on tourism and catering products, along with education on resource recycling and waste reduction, students' attitudes can be transformed. Additionally, VA acts as a mediating factor between EK and action intention (AI), indicating that while EK contributes to positive VA, it does not guarantee sustained responsibility toward environmental preservation and sustainable tourism concepts. Moreover, the study highlights the significant impact of AI on action sustainability marketing (ASM), suggesting the need for educational programs to include EK related to hospitality and management (H&M), consumer action information, and sustainable marketing strategies in their curriculum. Encouraging

sustainable practices and introducing sustainable solutions can inspire students to implement eco-friendly actions in their marketing strategies (Ferdous, 2010).

Furthermore, the study reveals that personal perceived benefits (PER) of big data mediate the relationship between students' individual awareness and risk perceptions. Educators should therefore promote awareness of the benefits of big data in their courses while addressing potential risks associated with its application (Gupta, 2021). By emphasizing personalized services and the positive impact of ABD, students can develop a more favorable attitude toward learning about big data and may also reduce their anxiety about this topic. Finally, the study examines the moderating effect of country (Australia and Taiwan) on students' attitudes toward sustainability and green marketing intentions. Despite initial differences, Taiwanese students showed increased levels of VA and AI compared to Australian students. Overall, this research sheds light on students' sustainable behavior patterns and the influence of big data applications on their environmental protection intentions, offering valuable insights for future practitioners in the tourism and hospitality industry.

5.3. Limitations and future works

The theoretical model applied in this study is the *S-O-R* model; however, there are several adequate models describing consumer behaviors in various contexts, such as the Theory of Planned Behavior (TPB), Behavior Reasoning Theory (BRT), Knowledge-Attitude-Practice (KAP) and the Technology Acceptance Model (TAM). Therefore, future works integrating different theories/models into this model are expected. Although the normality test mentioned above is not supported, it is important to note that the failure of statistical results to pass the normality test does not necessarily mean that the dataset cannot undergo statistical analysis. The scope of future works reducing the possibility of failing the normality test can focus on the following:

- (1) *Sample diversity*: Ensure that the sample is drawn from different cultural backgrounds, geographical regions, and social environments to enhance sample diversity, aiding in a better reflection of characteristics across various ethnic groups.
- (2) *Adequate Sample Size*: Ensure a sufficiently large sample size, which helps statistical analyses to reflect the characteristics of the entire population more accurately, not solely constrained by sample normality.
- (3) *Culture-Adaptive Measurement Tools*: Utilize questionnaires or measurement tools that have been culturally adapted to ensure that questions convey the same concepts accurately across different cultures, minimizing biases arising from language and cultural differences.
- (4) *Comparative Analysis*: Employ comparative analysis methods that emphasize differences between various cultures rather than merely pursuing sample normality.
- (5) *Cross-Cultural Collaboration*: Collaborate with experts from the relevant cultural background to ensure that research design and methods are more applicable in cross-cultural contexts.

6. Conclusion

This comprehensive investigation, conducted within a robust S-O-R framework, significantly advances our theoretical understanding of the mechanisms that underlie effective sustainability education. The proposed model establishes a solid foundation for future research aimed at cultivating sustainability perspectives and competencies among hospitality and tourism students across diverse cultural contexts.

Reference

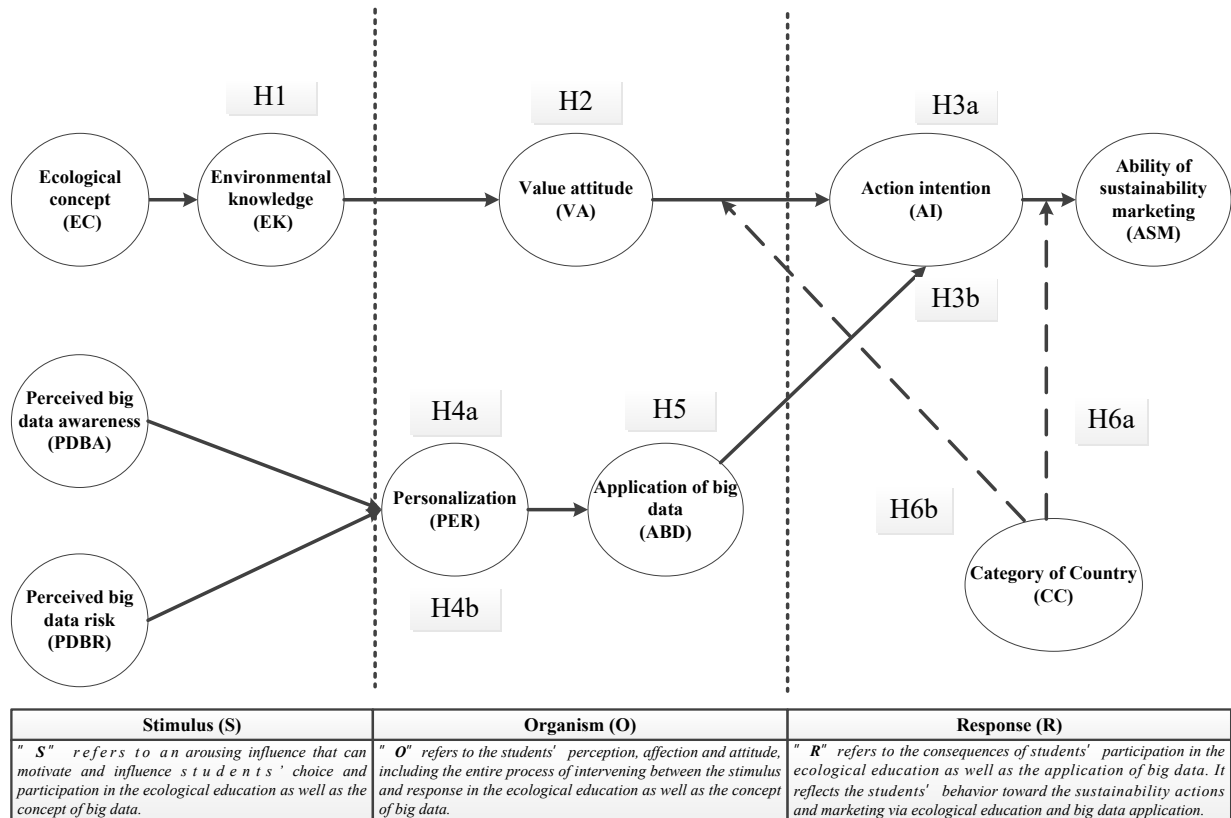
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Figure 1 Research Framework

Table 1 Descriptive Information of Participants

Item	Taiwan	Frequency (%)	Item	Australia	Frequency (%)
Gender/Sex	Male	123 (31.6%)	Gender/Sex	Male	103 (42.2%)
	Female	266 (68.4%)	Gender/Sex	Female	116 (47.5%)
	N/A	0 (0%)	Gender/Sex	N/A	25 (10.2%)
Age	Below 20	205 (52.7%)	Age	Below 20	18 (7.4%)
	21-25	176 (45.2%)	Age	21-30	192 (78.7%)
	26-30	5 (1.3%)	Age	Above 30	34 (13.9%)
	Above 30	3 (0.8%)			
Current year of study	1 year	98 (25.2%)	Current year of study	1 year	29 (11.9%)
	2 years	91 (23.4%)	Current year of study	2 years	48 (19.7%)
	3 years	108 (27.8%)	Current year of study	3 years	68 (27.9%)
	4 years	72 (18.5%)	Current year of study	4 years	82 (33.6%)
	Graduated	15 (3.9%)	Current year of study	Graduated	13 (5.3%)
	N/A	5 (1.3%)	Current year of study	N/A	4 (1.6%)

**N/A represents "Not answer."

Source(s): Authors' own illustration

Table 2 The analysis of reliability

Variable	Question number	No of item	Cronbach's α
EC	2-3, 5	3	0.74
EK	7, 9, 11	3	0.77
VA	13-15	3	0.79
AI	17-18	2	0.80
PBDA	34-36	3	0.80
PBDR	38-40	3	0.86
PER	41-43	3	0.87
ABD	44, 46-47	3	0.82
GMI	48-49, 51-52, 55, 57, 62	7	0.91

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Table 3 The analysis of coverage validity

Variable	Factor loading	Standard deviation	tvalue	Standardized estimate
EC	0.74	0.05	14.99***	0.60
	0.98	0.05	18.93***	0.73
	0.87	0.05	16.80***	0.66
EK	0.86	0.05	18.89***	0.69
	0.85	0.05	18.63***	0.68
	0.96	0.04	22.28***	0.78
VA	0.97	0.04	22.23***	0.77
	1.03	0.04	23.97***	0.81
	0.90	0.05	18.66***	0.68
AI	1.03	0.04	24.85***	0.84
	0.96	0.04	22.42***	0.78
PBDA	0.92	0.04	20.79***	0.75
	0.97	0.04	22.81***	0.80
	0.89	0.05	19.44***	0.71
PBDR	1.07	0.05	22.29***	0.78
	1.13	0.04	26.26***	0.88
	1.02	0.04	23.54***	0.81
PER	0.94	0.04	23.57***	0.80
	0.96	0.04	25.08***	0.84
	0.97	0.04	25.52***	0.84
ABD	0.87	0.04	21.72***	0.76
	0.95	0.04	23.56***	0.81
	0.89	0.04	21.75***	0.76
GMI	0.92	0.04	24.58***	0.82
	0.90	0.04	24.25***	0.81
	0.92	0.04	23.71***	0.80
	0.88	0.04	21.86***	0.75
	0.84	0.04	21.07***	0.73
	0.86	0.04	22.00***	0.76
	0.82	0.04	20.49***	0.72

Source(s): Authors' own illustration

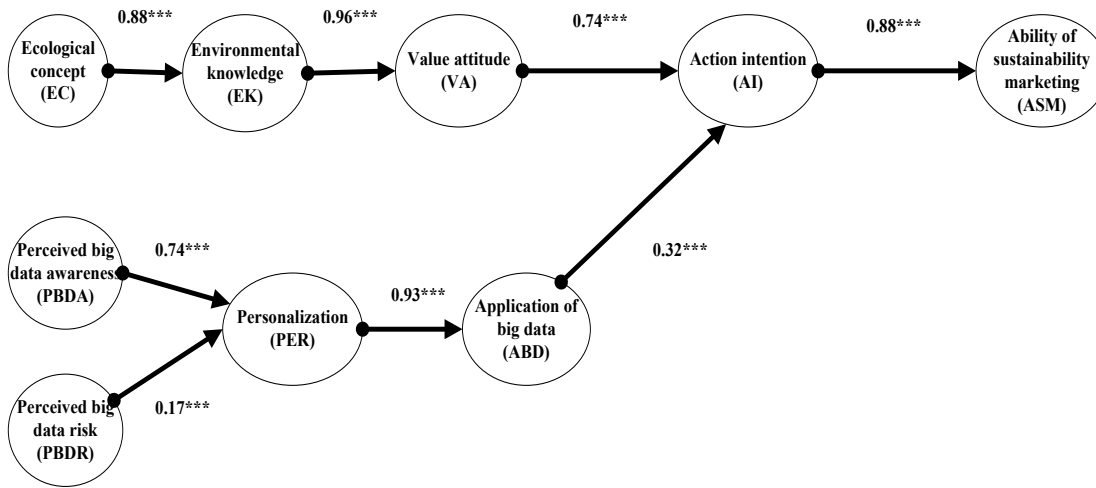
Table 4 Correlation analysis

Variable	Mean	Standard deviation	AVE	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
EC (1)	5.59	1.03	0.44	(0.70)								
EK (2)	5.33	1.02	0.52	0.67**	(0.76)							
VA (3)	5.22	1.08	0.57	0.66**	0.76**	(0.80)						
AI (4)	5.34	1.11	0.66	0.61**	0.69**	0.75**	(0.79)					
PBDA (5)	5.35	1.03	0.57	0.55**	0.52**	0.53**	0.50**	(0.80)				
PBDR (6)	5.02	1.15	0.68	0.33**	0.37**	0.37**	0.37**	0.48**	(0.86)			
PER (7)	5.25	1.03	0.68	0.51**	0.49**	0.53**	0.52**	0.67**	0.50**	(0.87)		
ABD (8)	5.28	1.00	0.60	0.51**	0.54**	0.56**	0.52**	0.64**	0.45**	0.77**	(0.82)	
GMI (9)	5.54	0.92	0.59	0.61**	0.63**	0.67**	0.71**	0.63**	0.48**	0.66**	0.69**	(0.91)

**Correlation is significant at the .01 level (2-tailed)

**The values of diagonal represent the composite reliability of 11 variables.

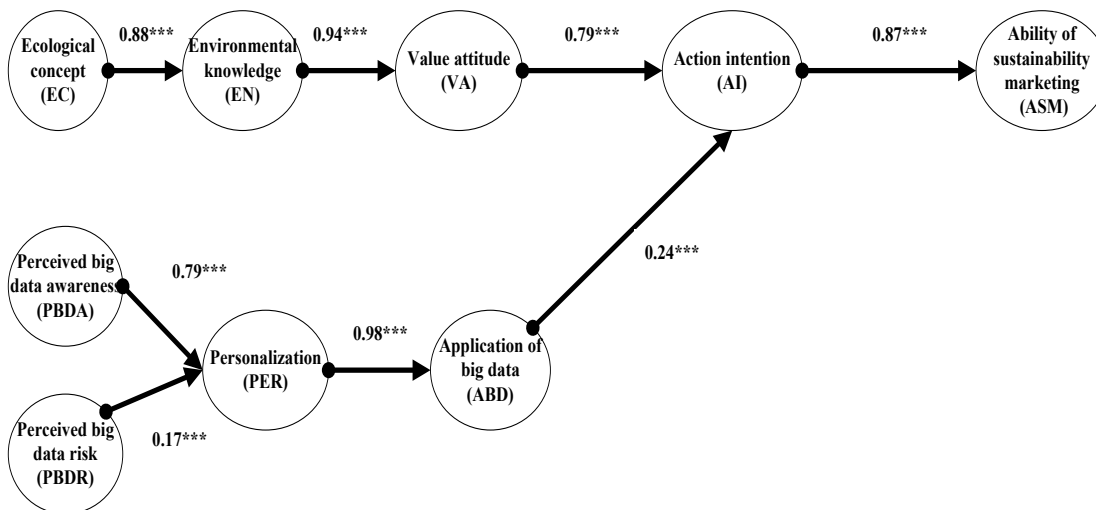
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Chi-Square=953.76, df=394, P-value=0.00000, RMSEA=0.047

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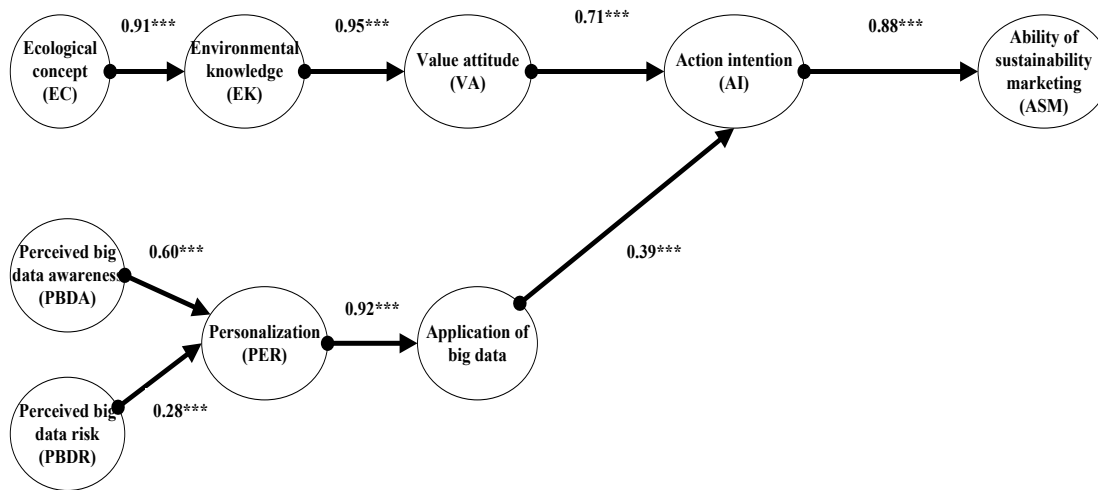
Figure 2 Path Analysis-Total



Chi-Square=650.77, df=264, P-value=0.00000, RMSEA=0.061

Source(s): Authors' own illustration

Figure 3 Path Analysis-Taiwan



Chi-Square=633.61, df=394, P-value=0.00000, RMSEA=0.050

Source(s): Authors' own illustration

Figure 4 Path Analysis-Australia

Table 5 Path Analysis-Total

Path	Standard deviation	Total effects		Hypotheses	Result
		β	t-value		
<i>EC->EK->VA</i>	0.05	0.85	17.96***	H1	Accept
<i>KN->VA->AI</i>	0.05	0.72	14.62***	H2	Accept
<i>VA->AI->GMI</i>	0.04	0.74	16.67***	H3a	Accept
<i>PBDA->PER->APD</i>	0.05	0.69	14.20***	H4a	Accept
<i>PBDR->PER->ABD</i>	0.04	0.16	4.00***	H4b	Accept
<i>PER->ABD->AI</i>	0.03	0.26	9.19***	H5	Accept
<i>ABD->AI->GMI</i>	0.03	0.28	9.03***	H3b	Accept

Note: "*" stands for $P < 0.05$; "***" stands for $P < 0.01$; "****" stands for $P < 0.005$

Source(s): Authors' own illustration

Table 6 Path Analysis-Taiwan

Path	Standard deviation	Total effects		Hypotheses	Result
		β	t-value		
<i>EC->EK->VA</i>	0.06	0.83	13.01***	H1	Accept
<i>KN->VA->AI</i>	0.07	0.75	10.18***	H2	Accept
<i>VA->AI->GMI</i>	0.06	0.69	11.50***	H3a	Accept
<i>PBDA->PER->APD</i>	0.06	0.77	13.16***	H4a	Accept
<i>PBDR->PER->ABD</i>	0.05	0.17	3.71***	H4b	Accept
<i>PER->ABD->AI</i>	0.05	0.24	4.93***	H5	Accept
<i>ABD->AI->GMI</i>	0.04	0.21	4.90***	H3b	Accept

Note: "*" stands for $P < 0.05$; "**" stands for $P < 0.01$; "***" stands for $P < 0.005$

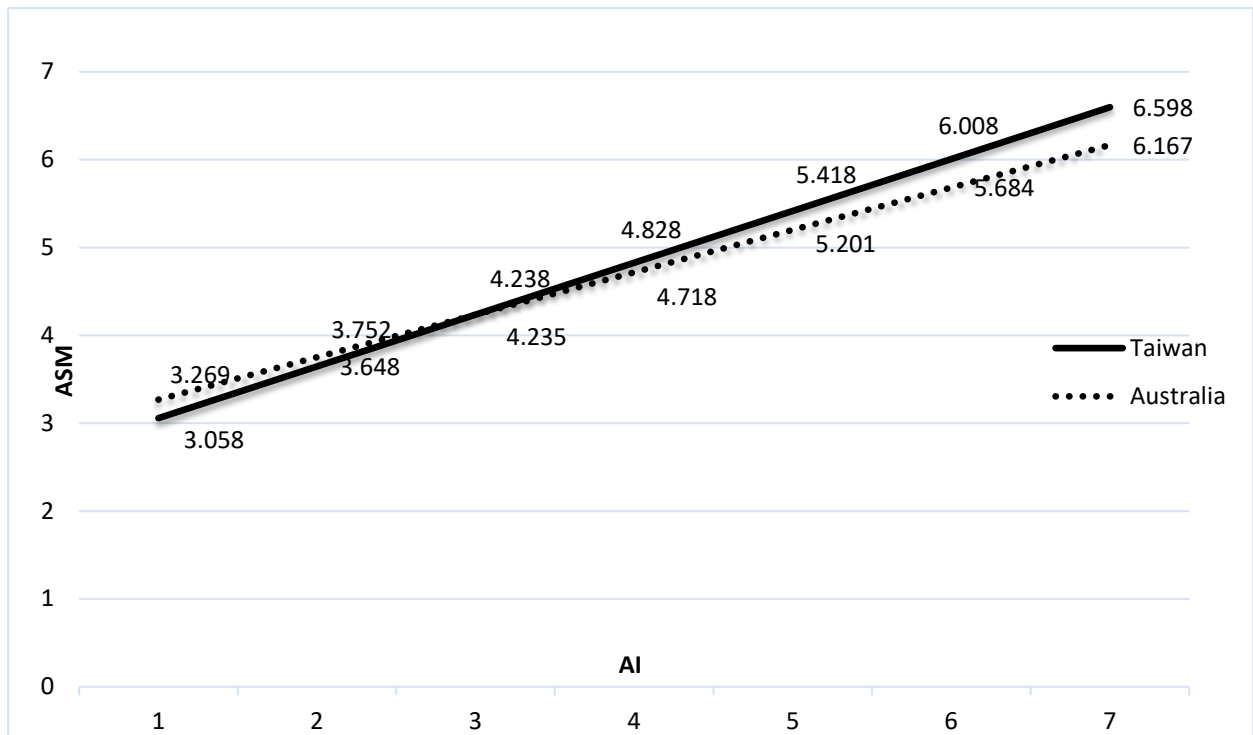
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Table 7 Path Analysis-Australia

Path	Standard deviation	Total effects		Hypotheses	Result
		β	t-value		
<i>EC->EK->VA</i>	0.08	0.87	10.32***	H1	Accept
<i>KN->VA->AI</i>	0.08	0.67	8.14***	H2	Accept
<i>VA->AI->GMI</i>	0.08	0.62	8.26***	H3a	Accept
<i>PBDA->PER->APD</i>	0.11	0.55	5.08***	H4a	Accept
<i>PBDR->PER->ABD</i>	0.10	0.26	2.57***	H4b	Accept
<i>PER->ABD->AI</i>	0.06	0.36	5.78***	H5	Accept
<i>ABD->AI->GMI</i>	0.06	0.34	5.77***	H3b	Accept

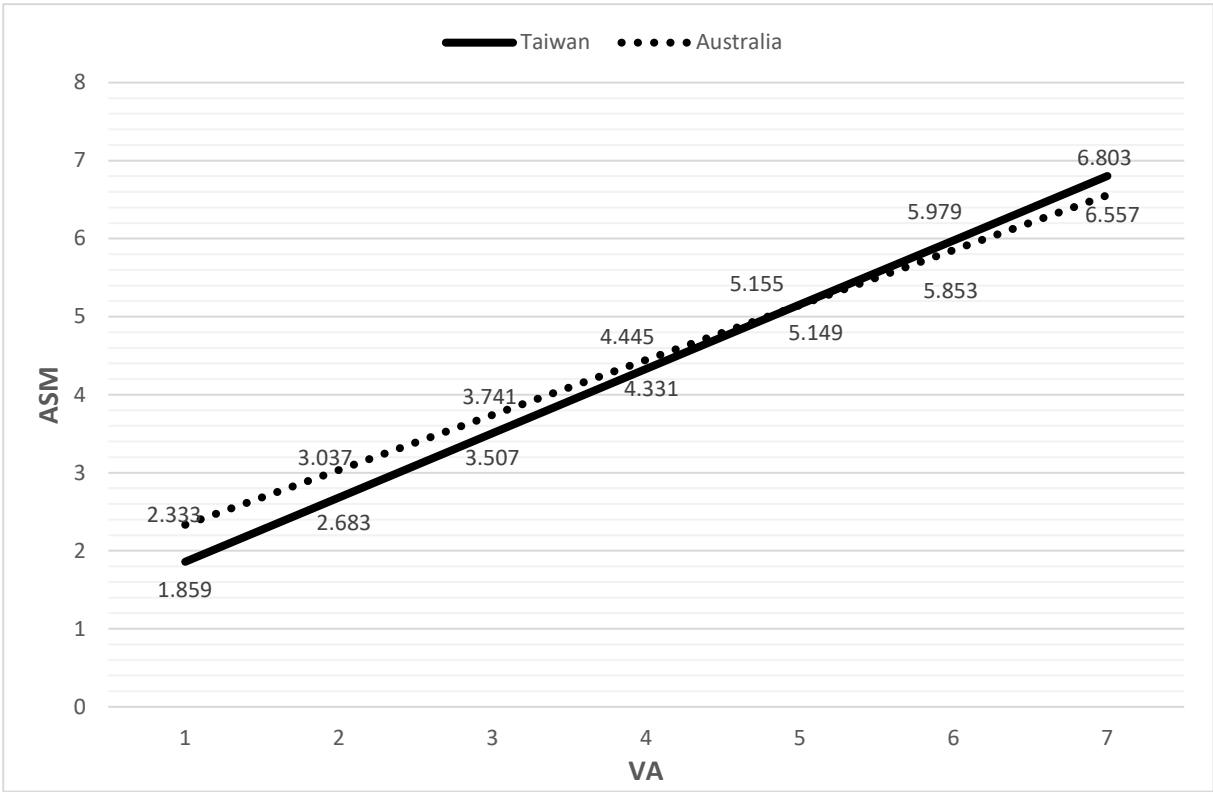
Note: "*" stands for $P < 0.05$; "**" stands for $P < 0.01$; "***" stands for $P < 0.005$

Source(s): Authors' own illustration



Source(s): Authors' own illustration

Figure 5 TYPE as a moderator of the relationship between AI and GMI



Source(s): Authors' own illustration

Figure 6 TYPE as a moderator of the relationship between VA and AI