



Virtual Reality for Assessing Willingness to Accept Compensation: An Exploratory Study of New Airport Noise Impact in Chiang Mai, Thailand

Teerapat Khowluang¹ and Preda Pichayapan^{1,2,†}

¹Department of Civil Engineering, Faculty of Engineering, Chiang Mai University, Chiang Mai 50200, Thailand

²Excellence Center in Infrastructure Technology and Transportation Engineering (ExCITE), Chiang Mai University, Chiang Mai 50200, Thailand

†Corresponding author: Preda Pichayapan; preda@eng.cmu.ac.th

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ABSTRACT

This exploratory study investigated virtual reality (VR) as a potentially more efficient tool for willingness to accept (WTA) compensation assessment in Thailand, as conventional contingent valuation methods (CVM) could be limited in assessing WTA for aircraft noise, which is vital, especially in the context of airport development. A comparative study (n=140) near a proposed new airport in Chiang Mai divided participants into VR and non-VR groups. Using a linear mixed model, the total WTA of the VR group was significantly higher, and the variance varied with noise intensity. Furthermore, VR's impact on WTA interacted significantly with gender, age, and educational level. Among the main drawbacks were the efficiency of the VR device, the noise model from an actual airport, and the lack of evaluation of prior VR experience or any adverse effects related to VR. Future research should consider these elements, investigate different VR configurations, and examine more general environmental influences to create more comprehensive policies.

INTRODUCTION

Although a major engine of the world's economic expansion, airport construction always results in environmental effects, and aircraft noise is a major issue for the surrounding people. The growing demand for air travel calls for both the construction of new airports and the expansion of current ones, thereby stressing the necessity of efficient noise-reduction techniques. Similar to many other nations, Thailand struggles with this; educated regional planning and policy development depend on research on the effects of airport noise and the value of these consequences. Three main components form this introduction: studies on noise valuation, VR in environmental valuation, and socioeconomic influences on WTA.

Noise Valuation Studies

Hedonic pricing models and stated preference methods are the two primary approaches used to accurately evaluate the impact of noise on the economy. Hedonic pricing can be utilized to determine the cost of noise. This method involves analyzing the relationship between noise levels and property values.

Many studies have found a statistically significant inverse relationship between noise levels and property values (for example, Friedt and Cohen 2019 found that noise abatement has effects; Winke 2017 found that prices are devalued when a new runway is opened). Poll results show that people living in houses in the Louder area are willing to pay less for their homes.

On the other hand, hedonic pricing theories could be useful tools despite their drawbacks. Changes in the market, for example, can take some time until a

new equilibrium is established. Almer et al. (2017) found that after a change in flying restrictions, rentals in the neighborhood of an airport required approximately two years to normalize. Using hedonic valuations, this data emphasizes the need to consider times of non-equilibrium. Schipper et al. (2001) found this while looking at how airplane noise affected home rents. They found that varying levels of noise have similar impacts on the costs of residential rentals.

Alternatively, stated preference methods, which include instruments such as the Contingent Valuation Method (CVM) and Choice Experiments, are used to directly elicit people's willingness to pay (WTP) or willingness to accept (WTA), thereby eliminating or compensating for noise effects. Research conducted in Thailand has shown WTA-related data in relation to airport noise exposure. Chalermpong & Klaikleung (2011) investigated university faculty personnel's WTA close to Suvarnabhumi Airport. The research revealed the mean WTA values and the effect of noise variations. Chalermpong & Klaikleung (2012) conducted another study using Choice Experiment to gauge the WTA connected with increasing aircraft operations for renters near the same airport. Kotchompoo (2022) examined the WTA of residents near Chiang Mai International Airport. The results of this study highlighted the considerable degree of noise effect as the main cause and revealed a great diversity of WTA values. In a study conducted close to a growing airport, Miyakawa et al. (2010) applied CVM to evaluate the economic disutility of sleep disruptions caused by both road traffic noise and airplanes. Their results showed variations in disutility based on disturbance frequency.

This study indicates that a vast variety of variables and the setting in which WTA values are applied influence them. These elements are personal and socioeconomic characteristics, the type of noise effect, and the particular group affected. It is also important to emphasize that, given that stated preference techniques can directly evaluate the value of intangible benefits, these methods are vulnerable to hypothetical bias, which suggests that respondents may not represent their actual preferences.

Virtual Reality on Environmental Valuation

Virtual reality (VR) has evolved into an intriguing tool for managing some of the natural limitations of conventional environmental assessment methods. By providing users with immersive and realistic simulations of environmental situations, VR holds enormous promise for increasing the accuracy and robustness of environmental assessments. By creating a VR toolchain capable of mimicking airplane noise under several operational processes and weather conditions, Arntzen et al. (2011) revealed the promise of this approach.

This feature specifies the noise interference. By asserting that training conducted on VR systems generates more knowledge acquisition and retention than traditional approaches in aircraft flying and maintenance situations, Ziakkas et al. (2023) further underlined the application of VR in training and educational contexts. Given its awareness of the major influence of contextual factors on noise perception, VR is a powerful tool for changing these variables. Dedieu et al. (2021) demonstrated VR's capacity to isolate and change environmental factors by means of research on how geography influenced the subjective pleasantness of simulated flyovers. Building on this effort, using visual and audio occlusion by buildings, Aalmoes et al. (2019) produced an auralization of a VTOL aircraft inside an urban area, hence significantly enhancing the realism of the simulation inside an Oculus Rift VR environment. This method corrects the shortcomings of earlier auralization algorithms, which occasionally overlooked urban ambient complexity. Sahai et al. (2012) developed a VR air traffic simulation with auralization and three-dimensional visualization to provide a more subjective assessment of noise impact, acknowledging the limitations of relying solely on numerical noise measures.

Aalmoes & Sieben (2021) used a Virtual Reality experiment to evaluate human perception and noise annoyance linked with drones and Personal Air Vehicles (PAVs) in an Urban Air Mobility (UAM) setting, addressing the changing noise concerns posed by novel aircraft types and comparing these impressions to those of more familiar sounds. Their trial considered personal noise sensitivity and included several audio-visual settings. Outside the sphere of noise evaluation, Lewis et al. (2016) investigated VR's ability to distract from discomfort-causing stimuli, including noise inside a simulated aircraft cabin, implying possible uses to improve passenger comfort.

Taken together, these studies indicate that virtual environments significantly increase the accuracy of environmental valuation. Compared to traditional methods, VR's greater realism and immersive experience aid in making situations more realistic, reducing hypothetical bias, and allowing dynamic real-world exposure patterns. This immediately addresses several limitations inherent to conventional valuation methods.

Socioeconomic Influences on WTA

Many people agree that people's views and reactions to environmental disamenities, such as noise, are greatly shaped by their socioeconomic situation. Indeed, Miyakawa et al. (2010) used the contingent valuation technique and found a statistically significant link between willingness to accept (WTA) for sleep disturbances and other socioeconomic

factors. Their results especially underlined a pattern of rising WTA with age, a WTA gradient across socioeconomic levels (with white-collar and executive professionals reporting a higher WTA than blue-collar workers), and a positive correlation with people's self-reported noise sensitivity.

Research in Thailand, on the other hand, points to a more complex and context-dependent interaction of variables. While Kotchompoo (2022) noted a tendency for households in larger homes and those occupied by people aged 31 to 40 years in the vicinity of Chiang Mai Airport to show higher WTA, other elements, including higher income levels, living in detached homes, greater geographical distance from the airport, and living in particular specific areas, were found to be related to lower WTA. In particular, the higher the perceived effect of noise, the higher the WTA. Moreover, subjective views had a noticeable influence: those who believed in good economic effects tended to lower their WTA, while those who acknowledged the negative effects or disagreed with certain mitigation plans raised it.

Chalermpong & Klaiklueng (2012), in their study of university staff near Suvarnabhumi Airport, discovered that WTA was greatly affected by elements including employment status, years of service, monthly rental cost, and plans about moving, as their findings matched the expected directions. Interestingly, they also stated that within their research population, demographic characteristics such as gender, age, marital status, and number of children did not seem to have a statistically significant effect.

Looking beyond the direct impact of perceived noise levels, the current studies emphasize the complex and context-sensitive character of socioeconomic elements in forming WTA. The development of fair and efficient noise compensation rules depends on a thorough understanding of these interactions, including personal attitudes and perceptions.

Relying on existing Contingent Valuation Method (CVM) frameworks to estimate the economic effects of airport noise may limit respondents' ability to completely imagine practical situations using standard questionnaires. Although virtual reality (VR) has great potential for developing immersive simulations, its use in the field of willingness-to-accept (WTA) evaluation—especially in the local context of Thailand—remains a relatively young area of study. This study attempts to fill this gap by assessing the impact of VR on WTA ratings of airport noise in Thailand. The study will control for a variety of relevant socioeconomic factors across a range of airport noise levels to allow a direct comparison of WTA values between participants responding via traditional questionnaires (the non-VR group) and those interacting with immersive VR-based simulations (the VR

group). The study will explicitly look at the WTA values stated by each group, explore how the difference in WTA changes as a function of the noise level expected to occur at this airport, and carefully assess the interaction between important socioeconomic factors and exposure to VR in affecting expressed WTA.

The expected outcomes are as follows:

- The WTA values were higher in the VR group than in the non-VR group.
- A varying difference in WTA between the groups across noise levels.
- The interaction between socioeconomic factors and VR exposure influences the WTA.

These expectations stem from the deeply engaging nature of VR, a feature we anticipate could lead to a more accurate understanding of how unpleasant noise is for individuals. With a clear aim to contribute to environmental impact assessments that reflect reality more closely, help shape noise control plans that are fair and effective for everyone, and encourage consideration of both social and environmental costs in the pursuit of sustainable development, this study offers an initial glimpse into whether VR could be a viable tool for assessing WTA within Thailand. We hope that this study will serve as a valuable starting point for future research efforts in this important field.

MATERIALS AND METHODS

This exploratory study investigates the feasibility and potential of Virtual Reality (VR) technology in evaluating Willingness to Accept (WTA) compensation for operational aircraft noise from a planned new airport in Chiang Mai province, Thailand, using a quantitative research method with an experimental design. Particularly in Chiang Mai, a key center for tourism, business, and culture in Northern Thailand, this study investigates the consequences of operational aircraft noise in the proximity of the airport, a vital element in development planning. Currently, Chiang Mai International Airport (CNX) is the main entry point for both domestic and foreign travel. Plans are underway to build a second airport, Lanna. Lanna Airport's site is expected to be approximately 22 kilometers from Chiang Mai International Airport, between the San Kamphaeng district in Chiang Mai and the Ban Thi district in Lamphun (Thansettakij 2024). The proposed site of the Lanna Airport (Chiang Mai Airport 2) and the Existing Chiang Mai Airport are shown in Fig. 1.

Since Lanna Airport is still in the planning stages, it is difficult to determine how the WTA would be affected. Traditional techniques that rely on hypothetical situations

and surveys, such as the Contingent Valuation Method (CVM), may produce inaccurate findings. Virtual reality technology is a creative substitute that can increase the precision of WTA evaluation. This study contrasts and compares the experimental group, which assessed WTA using virtual reality simulations of aircraft noise, with the control group, which measured WTA using conventional CVM questionnaires and hypothetical situations. The experimental group assessed the WTA using VR simulations of aircraft noise. The estimates (displayed on the right side of Fig. 2) indicate that the study area covers the suggested site of Lanna Airport, which falls inside the NEF 30-40 zone. This suggests that compensation policies must be established.

Lanna Airport is still under design; hence, the simulation of airplane noise uses the most recent CNX airport data (Fig. 2, left). The validity of the VR technique in assessing the value of Lanna Airport is supported by noise data from Chiang Mai Airport (CNX), an airport expected to have operational characteristics and aircraft types similar to Lanna Airport. Once operational, Lanna Airport is expected to alleviate air traffic congestion at Chiang Mai Airport (CNX) with similar flight operations and aircraft types, suggesting potentially comparable noise impacts. Therefore, the CNX noise data offer a fair starting point for VR simulations. Given the ongoing exploratory research now in progress and the currently available data, this approach is appropriate. However, achieving a good simulation that accurately reflects reality will require more data and preparation in the future.

Using high-resolution 360-degree cameras at Chiang Mai University, which is near CNX and sits within the NEF 30-40 zone, researchers recorded the real ambient noise inside residences. Among the many situations captured in this set of recordings were those with sounds from the takeoff and landing of planes. Audio calibration was performed before deployment by merging the film into a virtual reality simulation using 3D airplane models (Jessyara 2024) calibrated for position, size, and motion to simulate real-world conditions. An exact sound level meter was used to ensure that the noise levels produced by the virtual reality were fair and accurate reflections of the conditions in the real world.

Residents of the NEF 30–40 zone around CNX were assessed to validate the use and quality of the VR system. Using a questionnaire anchored in the VR-Check framework, three primary dimensions—immersion capacities, ecological relevance, and user feasibility—were assessed (Krohn et al. 2020). Additional divisions of these criteria included five subcategories: visual and aural realism, comparison to real-life occurrences, general scenario simulation capabilities, usability, and physical comfort. Participants rated each component on a five-point Likert scale (1 = extremely low to 5 = very high) and provided additional remarks. The results showed sufficient efficiency, with an overall average score of 4.41 out of 5.00.

The participants for the VR compensation valuation were residents near the proposed Lanna Airport. The sample size was determined by combining a non-parametric statistical method suitable for comparing two independent groups, the Wilcoxon-Mann-Whitney test, with the G*Power Analysis tool.

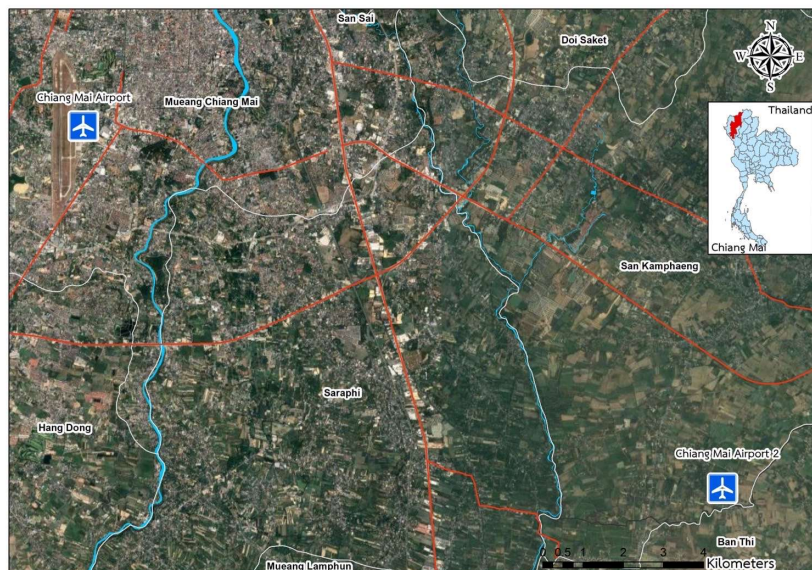


Fig. 1: Location of Chiang Mai Airport and Proposed Chiang Mai Airport 2.

Cohen's criteria were used to perform a two-tailed test with an equal allocation ratio ($N2/N1 = 1$), a significance level (α) of 0.05, a statistical power ($1-\beta$) of 0.80, and an effect size (d) of 0.5. The sample size was increased from the initial estimate of 67 individuals in each category (134 total) to 140.

Although general knowledge of the proposed Lanna Airport construction was strong in the community, the particular context of the study and the possibility of aircraft noise effects were clearly addressed to all participants during the informed consent procedure, thus addressing any possible selection bias. This guaranteed that the participants were clearly aware of the hypothetical scenario when they made their WTA judgments.

The survey had three parts: WTA assessment, basic demographic and socioeconomic data, and participants' reflections and comments. Based on Airports of Thailand Public Company Limited (2022) data, the WTA assessment's experimental group underwent a virtual reality simulation of airplane noise at L_{Amax} levels of 40, 60, and 80 dB(A), and the control group received scenario descriptions and other information. Selected to demonstrate a spectrum of noise exposure, these figures show that 40 dB(A) is the threshold at which effects begin, 60 dB(A) is comparable to the documented L_{Aeq} 24-hour values, and 80 dB(A) demonstrates the most expected effect but is still within the allowed exposure limits. Beginning with one thousand Thai Baht (Kotchompoo 2022), the WTA question used a double-bounded dichotomous choice approach with extra choices depending on the first response. The reliability of the questionnaire was demonstrated by Cronbach's alpha

coefficient, which had a value of 0.88, which is over the permissible limit of 0.7 (Nunnally 1978).

A Linear Mixed Model adequately evaluated the WTA data, which had a large number of observations spanning a wide spectrum of noise levels. Jiang & Nguyen (2021) show that this approach is appropriate for data suggesting correlations, especially in settings like ours, where repeated observations are gathered from the same people under many different environmental conditions. Adding the within-subject correlations produced by these ongoing noise level assessments allows this approach to increase the accuracy of the causal inferences obtained on the influence of VR treatment on WTA. Reaching this goal calls for consideration of both personal variety and complicating elements. VR was the main independent variable in the treatment group compared to the control group.

This study was approved by the Research Ethics Committee of Chiang Mai University (approval number: 074/67). The researchers protected the rights of the subjects by providing thorough justifications regarding the research goals, anticipated advantages, data collection techniques, possible hazards connected to VR device use, the right to consent or decline participation, the right to withdraw at any time, and the confidentiality of all collected data. The results of this study are provided only in aggregate form. To reduce potential discomfort, the researchers created a safe atmosphere for VR use, carefully tracked participants, and limited exposure time.

RESULTS AND DISCUSSION

Using a Linear mixed model, this study examined the

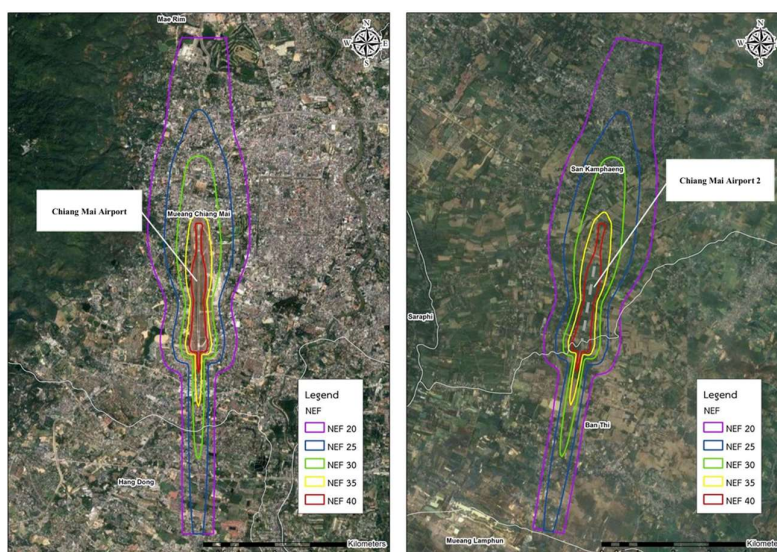


Fig. 2: NEF noise contour of Chiang Mai Airport (left) and Chiang Mai Airport 2 (right).

effects of virtual reality (VR) technology, different levels of simulated aircraft noise, and personal socioeconomic traits on Willingness to accept (WTA) compensation for aircraft noise impacts from a proposed new Chiang Mai Airport. This approach allowed us to statistically account for the impact of personal socioeconomic variables while isolating the specific impacts of VR and noise exposure. Comprising 140 people residing in the NEF 30-40 noise contour, the sample was appropriate for compensation. The socioeconomic profiles of the sample are presented in Table 1.

The sample group showed a wide variety of social characteristics. Slight majorities were married (61%) and male (54%). The majority of the respondents were over 39 years old (40%), followed by 20-29 years old (34%), then 30-39 years old (26%). Regarding education, 36% had schooling above the upper secondary level, whereas the largest group, 45%, had a lower secondary school education or less. Most (53%) said that their monthly income exceeded 15,000 THB. This variety guarantees that the analytical results fully capture the demographic features of the affected region.

While a linear mixed-effects model provides parameter estimates for the main effects, the presence of interaction terms between VR, noise level, and socioeconomic variables complicates their direct interpretation. Specifically, these main effect estimates represent conditional effects – the effect of one variable at a specific reference level of other interacting variables. This may not accurately reflect the overall effect of a factor across all levels of other variables. Therefore, Type III Tests of Fixed Effects were employed to assess the overall significance of each factor by averaging

the levels of other factors in the model and accounting for the interactions.

After adjusting for all other factors in the model, the Type III Tests of Fixed Effects in Table 2 show the relevance of each component (VR, noise level, and socioeconomic characteristics) to WTA. The analysis indicated extremely significant main effects for VR usage ($F = 60.60$, $p < 0.0001$), noise level ($F = 107.11$, $p < 0.0001$), age ($F = 7.79$, $p = 0.0005$), and education ($F = 8.52$, $p = 0.0003$). Overall, primary impacts were not shown by gender, marital status, or income. Notable interaction effects were also observed (VR \times Noise Level: $p = 0.0501$; VR \times gender: $p = 0.0103$; VR \times age: $p < 0.0001$; VR \times education: $p < 0.0001$), indicating that these variables shaped VR's impact on WTA.

A simple effects analysis was conducted to better understand the interaction effects and their direction, size, and specific group differences. Table 3 shows the simple effects of VR across all interaction factor levels, together with the estimated Cohen's d effect sizes to assess the practical significance of the observed differences. While Cohen's d , a standardized measure of effect size, shows the difference between two means in standard deviation units, β in this table displays the difference in Least Squares Means between the VR and Non-VR groups. Typically, a d of 0.2 is considered a small effect, 0.5 a medium effect, and 0.8 or above a large effect (Cohen 1988).

The overall analysis revealed that VR significantly increased WTA ($\beta = 623.70$, $p < 0.0001$) with a large effect size ($d = 2.03$). This positive β value indicates that, on

Table 1: Socioeconomic Characteristics of the Sample Group.

Socioeconomic Characteristics	Classes	n	%
Gender	Male	76	54%
	Female	64	46%
Age (years)	20-29	48	34%
	30-39	36	26%
	>39	56	40%
Marital Status	Not Married	54	39%
	Married	86	61%
Education Level	Up to Lower Secondary	63	45%
	Upper Secondary or Equivalent	26	19%
	Above Upper Secondary or Equivalent	51	36%
Income (THB)	< 10,001	32	23%
	10,001-15,000	34	24%
	> 15,000	74	53%

Table 2: Overall Effects and Interactions (Type III Tests).

Effect	F Value	¹ p-value
Main Effect		
VR	60.6	<.0001***
Noise Level	107.11	<.0001***
Gender	1.22	0.2701
Age	7.79	0.0005***
Marital Status	0.57	0.4501
Education Level	8.52	0.0003***
Income	1.77	0.1718
Interaction Effect		
VR x Noise Level	3.03	0.0501*
VR x Gender	6.68	0.0103**
VR x Age	10.51	<.0001***
VR x Marital Status	1.01	0.3161
VR x Education	17.05	<.0001***
VR x Income	0.28	0.7575

¹ significant: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Table 3: Simple Effects of VR (Differences of Least Squares Means).

Effect (of VR)	β	S.E.	t Value	¹ p-value	² effect size
Overall Comparison					
VR	623.70	80.12	7.78	<.0001***	2.03 (L)
Noise Level (L_{Amax} in dB(A))					
Low, 40 dB(A)	614.18	92.85	6.61	<.0001***	2.00 (L)
Medium, 60 dB(A)	728.46	92.85	7.85	<.0001***	2.37 (L)
High, 80 dB(A)	528.46	92.85	5.69	<.0001***	1.72 (L)
Socioeconomic Characteristics					
Gender					
Male	147.34	223.51	0.66	0.5103	0.48 (M)
Female	1100.06	175.65	6.26	<.0001***	3.58 (L)
Age (years)					
20-29	-58.11	219.48	-0.26	0.7914	-0.19 (S)
30-39	848.88	166.47	5.10	<.0001***	2.76 (L)
>39	1080.33	237.95	4.54	<.0001***	3.52 (L)
Marital Status					
Not Married	699.35	113.78	6.15	<.0001***	2.28 (L)
Married	548.06	106.01	5.17	<.0001***	1.78 (L)
Education Level					
Up to Lower Secondary	-30.16	123.23	-0.24	0.8068	-0.10 (S)
Upper Secondary or Equivalent	1108.64	158.12	7.01	<.0001***	3.61 (L)
Above Upper Secondary or Equivalent	792.62	130.97	6.05	<.0001***	2.58 (L)
Income (THB)					
<10,001	555.48	152.00	3.65	0.0003***	1.81 (L)
10,001-15,000	697.43	131.03	5.32	<.0001***	2.27 (L)
>15,000	618.19	104.35	5.92	<.0001***	2.01 (L)

¹ significant: *** p < 0.001, ** p < 0.01, * p < 0.05

² Effect Size (d): 0.2 (Small), 0.5 (Medium), 0.8 (Large)

average, participants in the VR group had a WTA that was 623.70 Thai Baht higher than those in the non-VR group, demonstrating a substantial overall impact of VR exposure.

With Large effect sizes across the low (40 dB(A), d = 2.00), medium (60 dB(A), d = 2.37), and high (80 dB(A), d = 1.72) noise conditions, further analysis of the basic impacts of VR at each noise level (L_{Amax} in dB(A)) indicated notable increases in WTA at all levels (all p-values < 0.0001). However, the effect was non-linear. The greatest impact occurred at 60 dB(A), which may be because, at this level, the loudness of the sound began to be clearly and consistently perceived as disruptive, allowing the VR to maximize the increase in this negative feeling. At 80 dB(A), which is already a very loud level, the additional impact of VR may be reduced because the feeling of annoyance from the sound may have reached a saturation point. At 40 dB(A), which is a quieter level, the effect of VR may also be less because the baseline noise is not yet sufficient to be

clearly perceived as bothersome enough for VR to amplify the effect. Other factors, such as the VR model, participant traits, and questionnaire design, may also play a role, but this most certainly indicates a relationship between baseline noise and VR improvement.

Focusing on socioeconomic characteristics revealed some unexpected correlations between VR and WTA. Especially interesting was the gender disparity: women who were exposed to virtual reality (VR) showed a significant rise in WTA (d = 3.58, p < 0.0001). This result is contrary to the relatively small and statistically negligible impact seen in men (d = 0.48, p = 0.5103). Differences in how men and women feel emotions, process spatial information, or are more likely to suffer from simulator sickness could help explain this gap.

Age also seems to have a major impact on VR responses. While younger adults (20-29) reported a modest, non-significant drop in WTA (d = -0.19, p = 0.7914), those in

the 30-39 ($d = 2.76$, $p < 0.0001$) and over-39 ($d = 3.52$, $p < 0.0001$) age groups exhibited very considerable increases. From this, one would infer that different life experiences, increased financial responsibilities and career demands, changing aspirations, or perhaps age-related changes in hearing sensitivity play a role. Moreover, although VR usually increased WTA for both married and single people, the impact appeared to be more pronounced for those not married ($d = 2.28$) than for their married counterparts ($d = 1.78$), indicating a higher sensitivity to disturbances in the home environment for those living alone.

There was a clear link between WTA answers and the degree of education. Those with at least an upper secondary level of education reported significant gains in their WTA after VR exposure. On the other hand, those with lower secondary education had a slight drop that was not statistically relevant ($d = -0.10$, $p = 0.8068$). Advanced education might enable individuals to handle the facts shown in a VR environment, hence promoting greater knowledge of the long-term consequences of noise pollution. Furthermore, a higher degree of education seems to be related to greater awareness of environmental effects and a stronger capacity to picture future situations, which would then affect their readiness to accept particular circumstances.

VR revealed consistent significant rises in WTA across all income brackets, despite the overall relationship with income not reaching statistical significance in our study, implying an impact across the economic spectrum. The immersive quality of virtual reality would suggest that it is especially good at increasing awareness of the effects of noise, perhaps even offsetting the usual tendency for those with more money to be less sensitive to noise. Essentially, regardless of one's financial situation, the VR experience seems to provide a more immediate and felt sense of possible disruption. The VR simulation may have provided a shared experiential basis that, to some degree, normalized the perception of the noise effect across different income levels, or perhaps the emotional reaction triggered by the simulation was so intense that it produced similar responses irrespective of the financial situation.

Effect sizes offer useful information, despite the fact that not all interactions with socioeconomic characteristics achieved statistical significance. A medium or high effect size may imply a real, although underpowered, influence, even when a p-value is greater than the common statistical significance threshold (0.05). When evaluating data, this underlines how important it is to consider both statistical and practical significance.

VR technology significantly increases aircraft noise Willingness-To-Accept (WTA) compared with traditional

assessment methods. The greater and different WTA of the VR group across all noise levels confirmed our first expected outcome. Demographically motivated, VR filed claims for compensation among college graduates, seniors and women. This implies that VR could be a complicated and sensitive instrument for assessing environmental effects, thereby allowing for more equitable remedies.

Our method acknowledges certain reasonable technological limits, including the performance requirements of the VR equipment employed and the degree of accuracy of the sound model. Moreover, we did not conduct a methodical evaluation of the adverse effects that VR use might bring about, including discomfort. Given that our primary focus was the specific problem of airplane noise, other relevant environmental impacts were not within the scope of our research. Importantly, the study did not gather information on people's prior knowledge of VR technology, a characteristic that is likely to greatly influence their stated WTA. Considering a person's VR knowledge, it is only natural to assume that a simulated noisy setting will provoke different reactions. Future studies should seek to reduce these constraints by including evaluations of past VR experience and any reported discomfort, investigating possible novelty effects connected with VR exposure, and using qualitative research techniques to obtain a better understanding of the underlying perceptions and experiences.

Our VR-based WTA evaluation offers exciting ideas for designing more equitable and comprehensive compensation schemes from a policy standpoint. Because VR affects declared WTA, legislators should consider using VR for immersive simulations of public consultation processes, especially among clear demographic groupings such as income. This strategy may promote educated public debate and support for projects. This proactive and detailed study of environmental effects during project conceptualization may help lead to development decisions that are more socially acceptable and sustainable.

CONCLUSIONS

This exploratory study investigated the impact of virtual reality (VR) technology on the willingness to accept (WTA) aircraft noise from a proposed new airport in Chiang Mai Province. It was found that participants using VR tended to show significantly higher WTA values than the non-VR group, both overall and at all three noise levels, which were in the range expected for the new airport. These higher WTA values from VR were particularly pronounced among women, older individuals, and those with higher education levels. This study highlights that virtual reality (VR) truly helps in assessing WTA. However, the study did not include

participants' prior virtual reality (VR) experiences, which might have influenced their reactions. Moreover, although a safe virtual reality environment and a technology verified for its usability were used, other types of virtual reality-related discomfort were not statistically investigated in the complete study.

To address these limitations, future research should evaluate VR-related discomfort and past virtual reality experiences. Studying the influence of novelty effects and using qualitative methods to characterize user subjectivity may assist in improving the validity of VR-based WTA assessments.

Ultimately, the inclusion of these changes might produce more consistent and dependable data that could support reasonable and efficient environmental laws and compensation schemes connected to airport noise and possibly other environmental changes with notable sensory characteristics.

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