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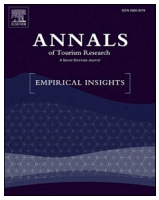

Point-to-point suborbital space tourism motivation and willingness to fly

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ABSTRACT

Suborbital space tourism is a catalyst for space industry revenue that could reach $1.1 billion by 2032. This study evaluated the influence of the four dimensions of Iso-Ahola's (1982) theory of tourism motivation on willingness to fly as a point-to-point suborbital space tourist. 870 participants responded to an online survey. The survey results were analyzed using structural equation modeling. The tourism dimensions of interpersonal seeking and personal seeking had the greatest influence on willingness to fly. The model explains 40% of the variance in willingness to fly. The results provide validated data for targeted marketing to potential point-to-point space tourists. The results of this study are a catalyst for future space tourism research.

1. Introduction

Suborbital space tourism is projected to produce a revenue of $1.1 billion for the commerical space industry by 2032. Ninety percent of all space travel is anticipated to be suborbital flights (Van Camp, 2023). Virgin Galactic, Blue Origin, and other companies have invested billions of dollars in making commercial space tourism a reality (Chang, 2020). In this emerging field, there are a few studies on tourism motivation and willingness to fly as a point-to-point suborbital space tourist. A better understanding of people who would be willing to make such flights can provide a focus for industry development (Berger, 2019, 2020; Bergin, 2020; Etherington, 2020; Laing & Frost, 2019; Virgin Galactic, 2020b; Wall, 2020; Zhang & Wang, 2020).

The Fédération Aéronautique Internationale defines *suborbital space tourism* as a flight in an airborne vehicle to an altitude exceeding 100 km (62 miles), which is the altitude of the Karman Line and the edge of space (Chang & Chern, 2018). A suborbital space tourist is a person paying to be brought "to sufficiently high altitudes [Karman Line] to watch the Earth's curvature and the blackness of space" (Chang, 2015, p. 79). Suborbital space tourism involves approximately 5 min of microgravity as the vehicle falls back toward earth. At some point before microgravity ends, the tourists will reattach their seatbelts for the return ride to the earth's surface near the point of departure (Blue Origin, 2020; Virgin Galactic, 2020a). Space tourism is less than two decades old and essentially emerged as a result of the Ansari XPRIZE for private spaceflight in 2004 (Ansari XPRIZE, 2018; Berrisford, 2018; Chang, 2015; Chang, 2020). Multiple companies are working to develop suborbital space tourism programs, most prominently Blue Origin and Virgin Galactic. Billions of dollars have been invested in attempts to be the first private organization to offer routinely scheduled and affordable suborbital spaceflights (Chang, 2020). Since the first commercial suborbital space tourism flights with passengers occurred in July 2021 (Foust, 2021a, 2021b), Blue Origin has flown 31 people above the Karman Line, and Virgin Galactic flew its first commercial SpaceShipTwo suborbital flight in June 2023 (Blue Origin, 2022; Foust, 2023).

Point-to-point suborbital space flight is the next step in commercial space tourism, and involves traversing distance horizontally as well as vertically. Point-to-point suborbital flight is faster than standard commercial airline flights and may be commercially viable by 2030 (Webber, 2010). High-speed aircraft that fly at 60,000 ft will be an incremental step toward point-to-point suborbital space travel; these are being developed by Virgin Galactic, with partners Rolls Royce and NASA (Virgin Galactic, 2020b). On May 5, 2020, NASA signed a Space Act Agreement with Virgin Galactic and The Spaceship Company, a subsidiary of Virgin Galactic, to develop a vehicle capable of point-to-point suborbital space flight. SpaceX is also planning point-to-point space travel with its Starship rocket from spaceports floating in the ocean (Berger, 2019, 2020; Bergin, 2020; Etherington, 2020; Wall, 2020). Finally, Dawn Aerospace has developed the Aurora for same-day suborbital space flights from multiple existing airports (Dawn Aerospace,

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2021). Understanding the influence of tourism motivation on willingness to fly as a point-to-point suborbital space tourist provides insights into who will choose to purchase a point-to-point suborbital space flight. Space tourism companies can use this information for marketing, training, and flight experience.

2. Literature review

Motivation is a force driving a person to satisfy needs in pursuit of a goal (Hsu, Cai, & Li, 2010; Khuong & Ha, 2014; Lubbe, 1998; Snepenger, King, Marshall, & Uysal, 2006; Yoon & Uysal, 2005). Motivation theories seek to define information on why humans behave in a certain way. The Yerkes-Dodson Law and Drive Theories were the early foundational constructs (Ryan & Deci, 2017). An individual is motivated when they seek a goal which will satisfy a need. The drive moves the individual to pursue that goal (Fodness, 1994). These three constructs (drive, goal, and need) have been incorporated into motivation theories as diverse as Maslow's hierarchy of needs, expectancy theory, the self-determination theory, and Plog's allocentric/psychocentric scale (Muchinsky, 2006; Plog, 2001; Robbins & Judge, 2013; Ryan & Deci, 2017).

Similarly, the push-pull theory has been developed as a theoretical framework for tourism motivation. Push factors predispose an individual to travel and result in a decision to take a vacation, while pull factors draw an individual to seek a particular location. Push factors are internal and exclusive, or innate, to a traveler and help explain the motives behind going on vacation; pull factors are external factors, which originate from the actual destination, and explain the selection of the vacation destination (Crompton, 1979; Dann, 1977; Jamrozy & Uysal, 1994; Klenosky, 2002; Yousefi & Marzuki, 2015). Push factors initially drive tourism motivation and are, at a minimum, antecedents to pull factors. Push factors are primary motivational factors while pull factors act as secondary motivational factors (Dann, 1977; Jamrozy & Uysal, 1994).

Dann (1977) and Crompton (1979) performed foundational research establishing anomie and ego-enhancement as initial push factors to vacation or pleasure tourism motivation. Anomic tourists' motivations stemmed from the need to get away (from life, work, home environment) and interact with people (other tourists, resort staff, residents) not in their everyday environment. Ego-enhancement tourists' motivations stemmed from prestige and increased status (Dann, 1977). Crompton (1979) qualitative research supported the concept of anomie and ego-enhancement as motivators as he discovered that an individual's vacation satisfaction was obtained primarily from seven social or psychological motives that are unique to the traveler rather than the destination. Iso-Ahola (1982) capitalized on push factors as antecedents to pull factors by developing a model of push factors.

Iso-Ahola (1982) developed an empirical theory of tourism motivation. They propose that tourism has two motivational forces: *seeking or escaping,* each of which may be *personal* or *interpersonal*. Iso-Ahola's theory allows tourist motivation to exist in four dimensions. A tourist might seek the personal aspect (rest and relaxation, ego-enhancement, recharging) or the interpersonal aspect (interacting with new people in a tourism group or at a tourism location). A tourist might escape the personal aspect (personal concerns and difficulties) or the interpersonal aspect (friends, family, co-workers).

Snepenger et al. (2006) originally operationalized Iso-Ahola's theory of tourism motivation by developing a scale to assess the four dimensions. Biswas (2008), Simková and Holzner (2014), and Thanabordeekj and Nipasuwan (2017) expanded on Snepenger et al. (2006) scale with research including Indian tourists, Chinese tourists, and comparison of rural and international tourists. Musselman and Winter (2023) modified Snepenger et al. (2006) original 12 items, and further validated Snepenger et al. (2006) model of Iso-Ahola (1982) theory of tourism motivation with application to point-to-point suborbital space travel. The current study used this modified tourism motivation scale and a willingness to fly scale developed by Rice et al. (2015), which was revalidated for use by airline passengers (Rice et al., 2020).

A better understanding of tourism motivation and willingness to fly as a point-to-point suborbital space tourist can provide insights into who will choose to participate in point-to-point suborbital space flight. It may also benefit space tourism companies by providing them with information that they can use to recruit potential passengers. The purpose of this study was to assess the influence of the four dimensions of this modified scale of tourism motivation on willingness to fly as a point-to-point suborbital space tourist. Age, gender, and annual income served as control variables.

3. Justification of factors selection and hypotheses

Several studies have investigated the willingness to fly as a commercial space tourist (Baugh, Musselman, Simpson, & Winter, 2018; Hill, Winter, & Rice, 2015; Mehta, Rice, Butalla, & Oyman, 2015; Winter & Trombley, 2019). Hill et al. (2015) and Mehta et al. (2015) studied the country of origin, gender, and commercial space flight. Both studies reported that women from the United States had less trust and were less willing to fly on commercial space flights than women from India. Trust from men was similar in both countries. Another study that analyzed a consumer's willingness to fly on an autonomously-controlled commercial spacecraft described a significant model that included a "fun factor," country of residence, and familiarity as predictor variables for willingness to fly (Baugh et al., 2018). Winter and Trombley (2019) identified familiarity, fun factor, wariness of new technology, anger, disgust, happiness, and sadness as significant predictors of a participant's willingness to fly to Mars. The use of the willingness to fly scale in these studies supports its use in research of point-to-point suborbital space tourists' willingness to fly (Rice et al., 2020).

Personal seeking involves a tourist pursuing rest and relaxation, ego-enhancement, and/or novelty. Astronauts and potential space tourists seek adventure, prestige, pride, novelty, and fun (Ao, 2018; Baugh et al., 2018; Chang, 2017; Laing & Frost, 2019; Olya & Han, 2020; Reddy, Nica, & Wilkes, 2012). Ao (2018) conducted a qualitative study that reviewed Tweets from astronauts, and discovered that astronauts were motivated by the adventure, prestige, and pride of space travel. Baugh et al. (2018) conducted research to identify variables that predicted a consumers' willingness to fly in an autonomously-controlled, commercial spacecraft. They found that the fun factor predicted willingness to fly, suggesting those willing to fly seek gratification in space travel. Chang (2017) researched four aspects of consumer innovativeness, or attraction, to the newness of space travel. Hedonic innovativeness refers to adventure, gratification, and experience, and influences both attitude toward and the novelty of space travel. An online survey of participants in the United States explored motivation antecedents of space traveler. Olya and Han (2020) found that adventure, gratification, and social motivation significantly influenced behavioral intentions. Reddy et al. (2012) found similar results reporting that participants from the United Kingdom were motivated for space travel by the uniqueness (novelty) and the fun experience of space travel. Laing and Frost (2019) identified nine key motivations in a qualitative study of four proposed space tourists, and two astronauts who had flown on the International Space Station. Although they identified a few additional motivations, their findings align with the studies previously described. A positive relationship between personal seeking and willingness to fly would therefore be expected.

Hypothesis 1. There is a significant positive relationship between personal seeking (PS) and willingness to fly.

Interpersonal seeking involves a tourist pursuing interactions with new people in a tourism group or location. Astronauts and potential space tourists desire this social aspect (Ao, 2018; Chang, 2017; Laing & Frost, 2019; Olya & Han, 2020). Ao (2018) found that astronauts desired meaningful human interactions by documenting and sharing their spaceflight experiences with others. Additionally, sightseeing was the

most prominent motivational theme of astronauts while in space. Chang (2017) found that social innovativeness, or a social need to be different, influenced both attitude toward and the novelty of space travel. Social motivation is an opportunity to socialize with people with similar interests. Information acquisition means that travelers are motivated by seeking knowledge about space travel. Olya and Han (2020) found that social motivation and information acquisition significantly influenced behavioral intentions. Laing and Frost (2019) identified nine key motivations. A positive relationship between interpersonal seeking and willingness to fly is therefore expected.

Hypothesis 2. There is a significant positive relationship between interpersonal seeking (IS) and willingness to fly.

A tourist who is evading personal concerns and difficulties is engaging in personal escape; a tourist evading friends, family, and/or co-workers is engaging in interpersonal escape. The justification for hypotheses 1 and 2 summarizes the research on space tourist motivation. To date, no studies have supported escape as a motivation for space tourism; however, in assessing the theory of tourism motivation, these two dimensions (personal escape and interpersonal escape) are assessed for influence on willingness to fly. It is hypothesized that there is a negative relationship between personal or interpersonal escape and willingness to fly as a suborbital point-to-point space tourist.

Hypothesis 3. A significant negative relationship exists between personal escape (PE) and willingness to fly.

Hypothesis 4. A significant negative relationship exists between interpersonal escape (IE) and willingness to fly.

Previous studies have shown that age influences tourism motivation (S.C. Chen & Shoemaker, 2014; Jönsson & Devonish, 2008; Kara & Mkwizu, 2020; Li, Li, & Hudson, 2013; Yousefi & Marzuki, 2015), but age is not the sole predictor of tourism motivation (Alén, Losada, & Domínguez, 2016; Kang, Pai, & Kim, 2019; Shavanddasht, 2017). Willingness to participate in a space flight decreases with age (Crouch, Devinney, Louviere, & Islam, 2009; Reddy et al., 2012), but previous studies of willingness to fly have shown mixed results regarding the effect of age on willingness to fly (Anania, Mehta, Marte, Rice, & Winter, 2018; Baugh et al., 2018; Lee, Kim, & Sim, 2019; Rice & Winter, 2019; Rice, Winter, Mehta, & Ragbir, 2019). In general, people are less willing to accept technology as they age (Cruz-Cárdenas, Zabelina, Deyneka, Guadalupe-Lanas, & Velí-Fárez, 2019; Mehta, Hruszczyk, Mickevicius, Friedenreich, & Rice, 2016; Rojas-Mendez, Parasuraman, & Papdopoulos, 2017). Controlling for age's influence on motivation and willingness was therefore justified (Becker et al., 2016; Bernerth & Aguinis, 2016).

A person's gender can influence motivation and willingness to fly. Men tend to be more likely to fly (Crouch et al., 2009), more trusting (Hill et al., 2015), and more interested (Reddy et al., 2012) in space flight than women. Men from the United States were nearly twice as willing to fly than were women from the United States. However, women from India were more willing to fly than men from India and the United States (Mehta et al., 2015). Finally, Baugh et al. (2018) and Winter and Trombley (2019) reported that gender was not a significant predictor of willingness to fly in space. Controlling for gender's influence on motivation and willingness was therefore theoretically justified (Becker et al., 2016; Bernerth & Aguinis, 2016).

Ticket cost influences willingness to pay for a spaceflight ticket (Collins, Stockmans, & Maita, 1996; Guerster, Crawley, & de Neufville, 2019). Mehta et al. (2019) hypothesized that participants with higher yearly incomes could choose to pay for luxury as their yearly income increases. However, Winter and Trombley (2019) did not find income as a significant predictor of willingness to travel to and live on Mars. Based on the potential influence of annual income on motivation and willingness, controlling the influence of annual income was theoretically justified (Becker et al., 2016; Bernerth & Aguinis, 2016).

4. Methods

Subjects were recruited via Amazon's ®Mechanical Turk®. All individuals who volunteered for the study were presented with a digital consent form and were required to agree to participate before proceeding with the survey. After consenting, participants were asked to provide their age, gender, annual income, country of residence, and ethnicity. Next, they were provided a definition of space tourism and the following scenario with a map depicting the flight path, "You will receive one day of pre-launch training the day before your flight. On the day of launch from Spaceport America in Las Cruces, NM, you will board the suborbital space vehicle. Your suborbital space flight travels around the globe flying over the midwestern United States and past the Great Lakes. The flight proceeds over southern Greenland, Ireland, England, France, Italy, Greece, Israel, Jordan, and Saudi Arabia. The flight proceeds between Antarctica and Australia and over the South Pacific before landing back at Spaceport America. This flight is provided to you free of charge (the flight does not cost you any money)." The participants were finally asked to respond with their level of disagreement or agreement on 12 statements from Musselman and Winter (2023) tourism motivation scale and 7 statements from the willingness to fly scale (Rice et al., 2020) (Table 2). The level of disagreement to agreement was indicated by participants on a 5-point Likert scale.

4.1. Analysis and statistics

The current study used a quantitative methodology and a non-experimental, cross-sectional survey design. Data analysis was conducted using confirmatory factor analysis and structural equation modeling. This study was approved by a University Institutional Review Board.

4.2. Pilot study

A pilot study was completed prior to the main study to detect potential problems with the research design or measurement instrument. Ninety-five participants (66 males and 29 females) from Amazon's ® Mechanical Turk ® responded to the pilot study. The initial confirmatory factor analysis showed unsatisfactory model fit (CFI = 0.907; GFI = 0.819; AGFI = 0.758; NFI = 0.783; RMSEA = 0.077; CMIN/df = 1.56). Modification indices for e2 and e3 were covaried. No other meaningful modification indices could be considered. The CFA model fit improved, but remained unsatisfactory (CFI = 0.917; GFI = 0.826; AGFI = 0.765; NFI = 0.793; RMSEA = 0.073; CMIN/df = 1.50). However, considering the small sample size of the pilot study, the modified values were considered sufficient to proceed with the main study.

Construct validity was assessed with Construct Reliability, convergent validity, and discriminant validity. Construct Reliability and Cronbach's Alpha values for all latent variables were greater than the acceptable value of 0.70. Convergent validity was acceptable with all factor loadings higher than the recommended value of 0.50 (Hair, Black, Babin, & Anderson, 2018). The average variance extracted for personal escape and interpersonal seeking were slightly lower than the acceptable value of 0.50. No changes based on the average variance extracted of personal escape and interpersonal seeking were deemed necessary due to adequate factor loadings, acceptable construct reliability, and the small size of the pilot study. Maximum squared variance values were lower than average variance extracted values for each latent variable; the square root of average variance extracted for each latent factor was greater than the inter-construct correlations. Thus, adequate discriminant validity was demonstrated for all latent variables. The construct validity was deemed sufficient to justify the full study without changes to the research design or measurement instrument.

4.3. Main study

Nine hundred and twenty-nine participants from the United States responded to the survey from Amazon's ® Mechanical Turk ® posted during the Fall of 2020. Participants from the pilot study were excluded from the main study. Data screening resulted in removal of 59 cases. Four respondents did not answer an attention check question, which simply asked them to select agree. Seven respondents were missing three responses for a latent variable. These eleven cases were deleted. Twenty-eight cases were removed due to not being engaged. These participants provided the same Likert response for nearly all of the statements for the Tourism Motivation observed variables. Two cases were removed due to stating they were from a country other than the United States. One participant was removed for providing a value of zero for annual gross income. Seven participants provided a blank response for annual income and were replaced with the median annual gross income of $45,000 for all respondents. One respondent replied with an age of 358, and the case was removed. Three respondents did not provide an age. These values were replaced with the average age of 37 for all respondents. Sixty-three missing values were identified across different variables. The surrounding values of the other observed variables for the latent variable were used to impute the missing value using known value replacement. For the univariate variables of annual gross income and age, outliers were detected in SPSS Statistics ® using a boxplot analysis to detect cases that fell greater than +/− 3 standard deviations away from the mean (Hair et al., 2018). There were fifteen outliers in terms of annual gross income, and these cases were deleted. There was one outlier for age, and the case was deleted. After data screening, 870 cases (574 males, 291 females, and 5 no response) were assessed as valid for data analysis.

Participant demographics are summarized in Table 1. Gender, age, ethnicity, and annual gross income were the demographic information collected for the study. The participants' demographic information indicated that 66.0% (574) identified as men and 33.4% (291) identified as women. This percentage of male and female participants is inconsistent when compared to the general population of the United States. The percentage of men and women aged 18 or older in the United States is approximately 48.0% and 52.0%, respectively (U.S. Census Bureau, 2019). The participant's gender is more consistent with the ratio of Amazon ® Mechanical Turk ® workers with 52.8% being men and 47.1% being women (Difallah, Filatova, & Ipeirotis, 2018).

As shown in Table 1, the survey participants18–29 years old (24.5%), although slightly higher, is fairly consistent with the general population of the United States between 18 and 29 years (20.9%). However, the other age groups were less consistent. Respondents 30–39 years (39.9%) and 40–49 years (22.4%) were higher than the same age groups within the general population of the United States. In contrast, the survey participants 50–59 years (8.3%) and those greater than or equal to 60 years (4.9%) were a lower percentage than the general population of the United States.

Table 1 shows the majority of respondents replied with the ethnicity of Caucasian (White, non-Hispanic) (88.6%). According to the U.S. Census Bureau (2021), residents of the United States who report as White, non-Hispanic is 60.1%, Black or African is 13.4%, Asian is 5.9%, Latino/Hispanic is 18.5%, and all other races are 4.3%. Although slightly lower, the ethnicity of respondents is relatively consistent with the percentage breakdown of the general population of the United States aside from Latino/Hispanic, which was only 2.2% of the respondents, but 18.5% of the United States' population.

Table 1
Summary of basic demographics characteristics – main study.

Characteristics	Subgroup Categories	Frequency (N = 870)	Percentage	Percentage of United States Population
Age	18–29 years	213	24.5%	20.9%
	30–39 years	347	39.9%	17.3%
	40–49 years	195	22.4%	15.9%
	50–59 year	72	8.3%	16.6%
	≥ 60 years	43	4.9%	29.3%
Gender	Male	574	66.0%	48.0%
	Female	291	33.4%	52.0%
	Blank	5	0.6%	
Ethnicity	Asian descent	29	3.3%	5.9%
	African descent	42	4.8%	13.4%
	Latino/Hispanic descent	19	2.2%	18.5%
	Caucasian (White, non-Hispanic)	771	88.6%	60.1%
	Other	9	1.1%	4.3%
Annual, Gross Income (USD)	< 15,000	45	5.2%	9.4%
	15,000-24,999	82	9.4%	8.7%
	25,000–34.999	140	16.1%	8.1%
	35,000-49,999	203	23.3%	11.6%
	50,000-74,999	242	27.8%	16.5%
	75,000-99,999	125	14.4%	12.2%
	100,000-149,999	29	3.3%	15.3%
	150,000-199,999	4	0.5%	8.0%
	200,000 and over	0	0.0%	10.3%

Table 2
Latent and observed variables used in the current study.

Latent Variable	Observed Variable	Mean	Standard Deviation (SD)
Personal Seeking (PS)	PS1: I feel this would increase value in myself	3.75	0.983
	PS2: I feel this would help me increase my self-worth	3.71	1.025
	PS3: I seek new experiences by myself	3.96	0.879
Interpersonal Seeking (IS)	IS1: I feel this helps me to meet new people	3.91	0.842
	IS2: I feel this provides opportunity to be with others of similar interests	3.91	0.855
	IS3: I feel this would allow me to participate in a novel interaction with others	3.99	0.875
Personal Escape (PE)	PE1: I feel this would help me get away from my personal environment	3.95	0.907
	PE2: I feel this would help me escape from my everyday life	3.90	0.930
	PE3: I feel this would result in a change in pace from my everyday life	4.06	0.854
Interpersonal Escape (IE)	IE1: I feel this would help me escape challenges in my social environment	3.57	1.081
	IE2: I fell this would help me avoid interactions with others in my everyday life	3.51	1.098
	IE3: I feel this would help me avoid others who annoy me in my everyday life	3.49	1.097
Willingness to Fly (WTF)	WTF1: I would be willing to fly in this situation	3.92	0.950
	WTF2: I would be comfortable flying in this situation	3.76	1.008
	WTF3: I would have no problem flying in this situation	3.71	1.012
	WTF4: I would be happy to fly in this situation	3.84	0.965
	WTF5: I would feel safe flying in this situation	3.70	1.024
	WTF6: I have no fear of flying in this situation	3.55	1.115
	WTF7: I feel confident flying in this situation	3.76	0.991

Table 3
Construct validity – CFA respecification.

Latent Variables	Recommended Value	Acceptable Value	Interim CFA	IS3 Removed	PE3 Removed	PS3 Removed
Personal Escape (PE)						
CR	>0.70	>0.60	0.649	0.648	0.630	0.630
Cronbach'sAlpha	>0.70	>0.70	0.642	0.642	0.628	0.628
AVE	>0.50	>.414[a]	**0.385**	**0.386**	0.461	0.461
MSV	<AVE	<AVE	**0.461**	**0.406**	0.366	0.365
Interpersonal Escape (IE)						
CR	>0.70	>0.60	0.800	0.800	0.800	0.800
Cronbach's Alpha	>0.70	>0.70	0.799	0.799	0.799	0.799
AVE	>0.50	>.414[a]	0.571	0.571	0.571	0.571
MSV	<AVE	<AVE	0.391	0.389	0.389	0.388
Personal Seeking (PS)						
CR	>0.70	>0.60	0.727	0.728	0.728	0.770
Cronbach's Alpha	>0.70	>0.70	0.671	0.671	0.671	0.769
AVE	>0.50	>.414[a]	0.481	0.481	0.481	0.626
MSV	<AVE	<AVE	**0.520**	**0.608**	**0.608**	0.536
Interpersonal Seeking (IS)						
CR	>0.70	>0.60	0.639	**0.586**	**0.586**	**0.586**
Cronbach's Alpha	>0.70	>0.70	0.639	**0.586**	**0.586**	**0.586**
AVE	>0.50	>.414[a]	**0.375**	0.414	0.414	0.414
MSV	<AVE	<AVE	**0.520**	**0.608**	**0.608**	**0.536**
Willingness to Fly (WTF)						
CR	>0.70	>0.60	0.890	0.890	0.890	0.890
Cronbach'sAlpha	>0.70	>0.70	0.891	0.891	0.891	0.891
AVE	>0.50	>.414[a]	0.537	0.538	0.538	0.537
MSV	<AVE	<AVE	0.371	0.3706	0.370	0.317

Note: Bold numbers identify less than acceptable value. [a]with CR >0.60.

Table 4
Discriminant validity – modified CFA.

Latent Factors	IE	PS	IS	PE	WTF
IE	**0.755**				
PS	0.623	**0.791**			
IS	0.478	0.732 [a]	**0.644**		
PE	0.502	0.403	0.604	**0.679**	
WTF	0.457	0.563	0.559	0.365	**0.733**

Note. Bolded numbers are the square root of AVE. [a] inter-construct correlations greater than the square of AVE.

Table 5
Heterotrait-monotrait ratio of correlation (HTMT) – modified CFA.

Correlation	HTMT ratio
WTF <–> IE	0.456
WTF <–> PE	0.380
WTF <–> IS	0.563
WTF <–> PS	0.559
IE <–> PE	0.504
IE <–> PS	0.623
IE <–> IS	0.476
PE <–> IS	0.608
PE <–> PS	0.409
IS <–> PS	0.733

The majority of respondents reported an annual gross income of $50,000 to $74,999 (27.8%) and $35,000 to $49,999 (23.3%). The median reported annual, gross income for the study was $45,000 compared to $67,521 for the United States' population. The mean reported annual gross income for the study was $48,600 compared to $97,026 for the United States' population (Shrider, Kollar, Chen, & Semega, 2021). The median, mean, and percentage of respondents with an annual gross income less than $15,000 or greater than $100,000 is lower when compared to the United States' population. The remaining income categories from the study are higher among respondents when compared to the United States' population.

Table 6
Hypotheses testing for SEM with control variables.

Hypotheses / Control Variable	Standardized Estimate	Unstandardized Estimate	*p*-value	Supported (Yes/No)
H_1: There is a significant positive relationship between personal seeking and willingness to fly	0.210	0.163	0.027	Yes
H_2: There is a significant positive relationship between interpersonal seeking and willingness to fly	0.329	0.367	0.003	Yes
H_3: There is a significant negative relationship between personal escape and willingness to fly	0.026	0.024	**0.719**	No
H_4: There is a significant negative relationship between interpersonal escape and willingness to fly	0.142	0.107	0.019	No
Gender <–> WTF	−0.113	−0.151	***	N/A
Age <–> WTF	−0.080	−0.005	0.020	N/A
Annual Income <–> WTF	0.037	0.000	**0.236**	N/A

Note: Bold numbers identify less than acceptable value.

Table 7
Future research – tourism motivation and willingness to fly as a point-to-point suborbital space tourist.

Construct	Hypothesis	Scale	Sources
Interpersonal Escape	To what extent does interpersonal escape influence willingness to fly as a point-to-point suborbital space tourist?	Modified tourism motivation scale (Musselman & Winter, 2023)	Laing & Frost, 2019
Curiosity	To what extent do curiosity factors influence willingness to fly as a point-to-point suborbital space tourist?	Five-Dimension Curiosity Scale-Revised (Kashdan, Disabato, Goodman, & McKnight, 2020)	Christensen et al., 2019; Kashdan et al., 2018; Lowenstein, 1994; Silvia, 2019; Woo et al., 2014
Collectivism	To what extent does collectivism influence willingness to fly as a point-to-point suborbital space tourist?	Individual Cultural Value Scale (Yoo, Donthu, & Lenartowicz, 2011)	Nayeem, 2012; Prebensen, 2005; Risitano et al., 2017
Uncertainty Avoidance	To what extent does uncertainty avoidance influence willingness to fly as a point-to-point suborbital space tourist?	Individual Cultural Value Scale (Yoo et al., 2011)	Litvin et al., 2004; Money & Crotts, 2003
Age	To what extent does age influence willingness to fly as a point-to-point suborbital space tourist?	NA	S.C. Chen & Shoemaker, 2014; Jönsson & Devonish, 2008; Kara & Mkwizu, 2020; Li et al., 2013; Yousefi & Marzuki, 2015
Gender	To what extent does gender influence willingness to fly as a point-to-point suborbital space tourist?	NA	Baugh et al., 2018; Crouch et al., 2009; Hill et al., 2015; Mehta et al., 2015; Reddy et al., 2012 Winter & Trombley, 2019
Country of Residence	To what extent does country of residence influence willingness to fly as a point-to-point suborbital space tourist?	NA	LeGoff & Moreau, 2013; The Tauri Group, 2014

5. Results

5.1. Confirmatory factor analysis

The measurement model was assessed with confirmatory factor analysis. Mahalanobis distance (D^2) was used to check for outliers. There were no outliers; therefore, all cases were included in the analysis. The initial model fit indices were acceptable except for the Comparative Fit Index and Normed Chi-Square. Comparative Fit Index at 0.947 was just slightly lower than the recommended value of 0.95. Normed Chi-Square at 3.291 was slightly higher than the recommended value of <3.0. Using an iterative process, error terms with high modification indices, that aligned with the theory of the model, were covaried. Error terms for e2 and e3 and e13 and e16 were covaried; this model achieved acceptable fit.

After establishing model fit, the next step was to assess construct validity using Construct Reliability, convergent validity, and discriminant validity metrics. Construct Reliability and Cronbach's Alpha values for personal escape, personal seeking, and interpersonal seeking were lower than the proposed acceptable value of 0.70. A Construct Reliability of 0.60 is acceptable in exploratory research (Hair Jr. et al., 2021). The current study is a confirmatory study, but this study did represent the first attempt of using the tourism motivation scale with the willingness to fly scale. Bagozzi and Yi (2012) support some latitude in factor loadings below 0.70 and the cutoff for Construct Reliability and Cronbach's Alpha with models that have satisfactory model fit. For these reasons, Construct Reliability and Cronbach's Alpha were considered moderately acceptable for all variables.

Convergent validity was supported with all factor loadings higher than the recommended value of 0.50 (Hair et al., 2018). PS3 was the lowest factor loading (0.497), which is close enough to 0.50. The average variance extracted for personal escape, personal seeking, and interpersonal seeking were lower than the acceptable value of 0.50. Adequate convergent validity, therefore, was not demonstrated for these latent variables. Additionally, adequate discriminant validity was not demonstrated. For personal escape, personal seeking, and interpersonal seeking, the value of maximum shared variance is higher than that of average variance extracted. Also, except for personal seeking and interpersonal seeking, and interpersonal seeking and personal escape, the square root of average variance extracted for each latent variable is greater than the inter-construct correlations. Convergent and discriminant validity were not acceptable. Model respecification was explored to improve construct validity. We deleted an observed variable in a stepwise fashion to increase convergent and discriminant validity (Hair Jr. et al., 2021). One observed variable was removed from personal escape, personal seeking, and interpersonal seeking, respectively. Table 3 displays convergent and discriminant validity values following the removal of each observed variable.

The modified confirmatory factor analysis achieved acceptable model fit, although, some concerns with construct validity remained. As shown in Table 3, the Construct Reliability and Cronbach's Alpha for interpersonal seeking are below 0.60, the average variance extracted is below 0.50, and maximum shared variance is greater than average variance extracted. Additionally, the average variance extracted for personal escape is lower than the recommended value of 0.50, which does not meet the recommended value of >0.50; however, Fornell and Larcker (1981) suggest an average variance extracted equal to >0.414 is acceptable with a Construct Reliability above 0.60. Personal escape meets these criteria with a Construct Reliability of 0.630 and an average variance extracted of 0.461; personal escape therefore demonstrated adequate convergent validity. The maximum shared variance greater than average variance extracted for interpersonal seeking demonstrated a discriminant validity issue according to Fornell and Larcker (1981) measurement. Additionally, a discriminant validity concern for interpersonal seeking is shown in Table 4 with the inter-construct correlation between interpersonal seeking and personal seeking greater than the square root of average variance extracted for interpersonal seeking.

The heterotrait-monotrait ratio of correlation has been shown to be an acceptable measure of discriminant validity (Byrne, 2016; Hair Jr. et al., 2021; Henseler, Ringle, & Sarstedt, 2015) and is the average of the correlations of observed variables across latent variables relative to the average of the correlations of the observed variables within the same latent variable. The heterotrait-monotrait ratio of correlation establishes construct validity with a more systematic discriminant validity assessment. Discriminant validity issues exist when heterotrait-monotrait ratio of correlation values are high; 0.85 is a conservative threshold value for demonstrating discriminant validity (Hair Jr. et al., 2021; Henseler et al., 2015; Kline, 2016). Table 5 shows heterotrait-monotrait ratio of correlation values for the modified confirmatory factor analysis; all values are below 0.85. The heterotrait-monotrait ratio of correlation demonstrated acceptable discriminant validity. The construct reliability of interpersonal seeking was the remaining unacceptable measure with Construct Reliability and Cronbach's Alpha of 0.586. Further modification of the confirmatory factor analysis was not justifiable, so we

proceeded with the structural equation model despite the slightly lower than acceptable construct reliability of interpersonal seeking.

5.2. Full structural model

The full structural model is depicted in Fig. 1 including gender, age, and annual income as control variables and standardized estimates for the four proposed hypotheses. The full structural model was assessed using IBM SPSS ® AMOS 27. The full structural model demonstrated acceptable model fit (CFI = 0.984; GFI = 0.975; AGFI = 0.963; NFI = 0.963; RMSEA = 0.028; CMIN/df = 1.703).

Hypotheses testing is summarized in Table 6. Hypotheses 1 and 2 were supported. Hypothesis 3 and 4 were not supported. Gender and age were statistically significant as control variables, but the annual income did not reach significance. The model explained 40% of the variance in willingness to fly. The results were analyzed with and without the control variables (Becker, 2005). The model without control variables had an R^2 for the willingness to fly of 0.379. This was only a slight decrease of 0.023 from the model with the control variables, which had an R^2 for the willingness to fly of 0.402. The control variables appear to explain this slight change, but the results suggest the control variables did not significantly contribute to the model. The results suggest no substantial changes to path strength, direction, or significance. The final model is shown in Fig. 1.

6. Discussion and conclusion

6.1. Theoretical implications

In this study, we assessed the influence of the four dimensions of the theory of tourism motivation on willingness to fly as a point-to-point suborbital space tourist. Personal seeking and interpersonal seeking were significant and positively related to the willingness to fly. Interpersonal escape was significant and positively related to willingness to fly. This suggests that as ratings of these three exogenous variables increased, so did the willingness to fly as a point-to-point suborbital space tourist.

Hypothesis 1 proposed a significant positive relationship between personal seeking and willingness to fly. A tourist motivated by personal seeking is pursuing rest and relaxation, ego-enhancement, and/or novelty. As expected, the full structural model supported this relationship as astronauts and potential space tourists seek adventure, prestige, pride, novelty, and fun (Ao, 2018; Baugh et al., 2018; Chang, 2017; Laing & Frost, 2019; Olya & Han, 2020; Reddy et al., 2012). Astronauts are motivated by the adventure, prestige, and pride of space travel (Ao, 2018). An individual's attitude toward space travel is one of adventure, gratification, and experience; novelty partially mediates this relationship (Chang, 2017). Excitement, novelty, and distinction are among the key motivations for space travel (Laing & Frost, 2019), and adventure, gratification, and desire to experience novel travel are motivation antecedents of space travel behavior intentions (Olya & Han, 2020). The findings in this study suggest that willingness to fly as a point-to-point suborbital space tourist is motivated by the personal seeking dimension of tourism motivation.

Hypothesis 2 proposed a significant positive relationship between interpersonal seeking and willingness to fly. A tourist motivated by interpersonal seeking is pursuing interaction with new people in a tourism group or location. As expected, the full structural model supported this relationship. Previous research demonstrates astronauts and potential space tourists desire the social aspect of experiencing space flight and sharing that experience through human interaction (Ao, 2018; Chang, 2017; Laing & Frost, 2019; Olya & Han, 2020). Astronauts desire meaningful human interactions by documenting and sharing their spaceflight experiences with others (Ao, 2018; Stott, 2021). Social innovativeness significantly influenced a person's attitude toward space travel. This relationship was partially mediated by the novelty suggesting people were motivated by being new and different when comparing themselves to those who did not experience space travel (Chang, 2017). Pro-social motivation, which is sharing information about space travel with others, was a key motivation for space travel

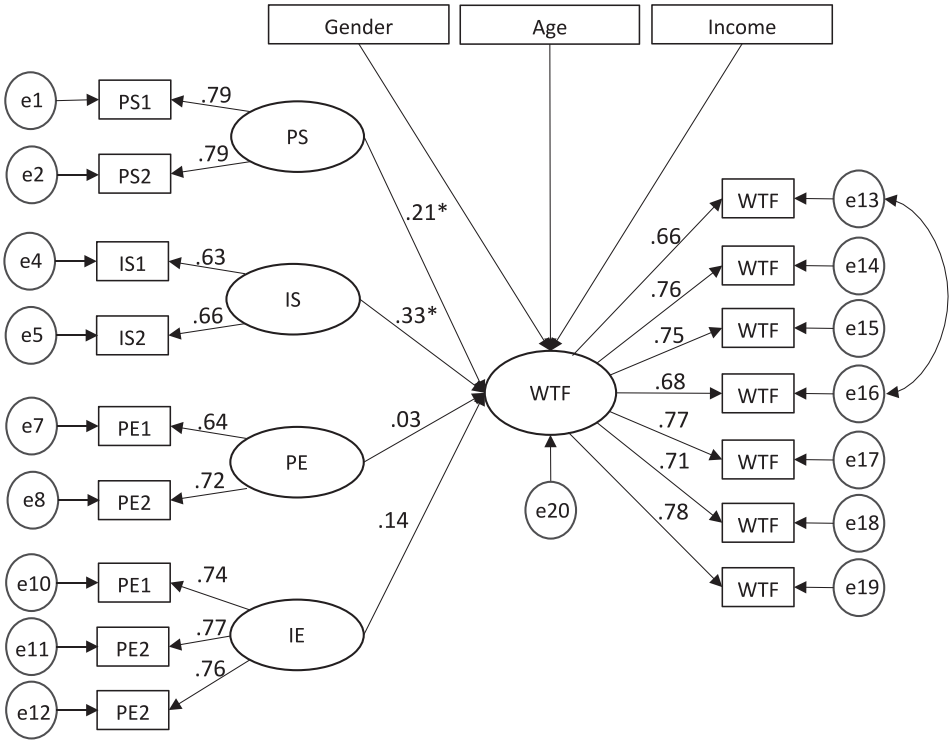

Fig. 1. Final structural model with standardized factor loadings.
Note. *significant at the level of 0.05.

(Laing & Frost, 2019; Stott, 2021). Social motivation, defined as the motivation to socialize with friends, family, and other people with similar interests, influenced people's attitudes toward space travel (Olya & Han, 2020). The findings from this study suggest that willingness to fly as a point-to-point suborbital space tourist is motivated by the interpersonal seeking dimension of tourism motivation.

Hypothesis 3 proposed that there is a significant negative relationship between personal escape and willingness to fly. A tourist motivated by personal escape is evading personal concerns and difficulties. The full structural model did not support this relationship and suggests that the personal escape dimension did not significantly influence willingness to fly as a point-to-point suborbital space tourist. No other research, related to space tourism, was discovered that applied the theory of tourism motivation using structural equation modeling; therefore, this study is unique in reporting that personal escape did not significantly influence space tourism.

Hypothesis 4 proposed that there is a significant negative relationship between interpersonal escape and willingness to fly. A tourist who is motivated by interpersonal escape is evading friends, family, and/or co-workers. The full structural model did not support this hypothesis as the results show a significant positive relationship between interpersonal escape and willingness to fly. While it may be tempting to treat a *p*-value of 0.019 as significant, a one-tailed test only allows for a rejection of the null hypothesis in the predicted direction. Therefore, this *p*-value must be treated no differently than a non-significant *p*-value.

This study extended the use of Iso-Ahola (1982) theory of tourism motivation to assess the influence on willingness to fly as a point-to-point suborbital space tourist. Additionally, it built upon the results of prior work by Musselman and Winter (2023). The study supports recommendations for more empirical studies to expand space tourism research and provides a model for application in future space tourism research (Laing & Frost, 2019; Zhang & Wang, 2020). Finally, this study furthered the use of the willingness to fly scale; this is the first known study to use the willingness to fly scale with point-to-point suborbital space tourism.

6.2. Practical applications

We found that personal seeking and interpersonal seeking, two dimensions of Iso-Ahola's theory of tourism motivation, affects individual's willingness to fly as a commercial space tourist. We have also developed a new theoretical model of motivators for point-to-point suborbital space tourism. The theoretical model explains 40% of the variance in willingness to fly as a point-to-point suborbital space tourist. This study established a baseline for participants' tourism motivation and willingness to fly as a point-to-point suborbital space tourist. The study's results provide validated data for targeted marketing to policymakers and potential point-to-point space tourists and investors.

The space tourism industry should focus on the interpersonal seeking and personal seeking dimensions of tourism motivation when developing marketing strategies for point-to-point suborbital space tourism. There should be deliberate focus on the interactions between space flight participants. These interpersonal interactions should be accomplished during pre-flight operations and training, the actual flight, and/or post-flight celebration or review. The commercial space industry should also purposefully develop a means for point-to-point suborbital space tourists to document and share their spaceflight experiences with others through social media, framed photos, and personal video.

The space tourism industry should market the adventure and fun of engaging in a point-to-point suborbital space tourism flight in conjunction with the novelty, prestige, and pride of the flight experience. The space tourism industry should place emphasis on the adventure and fun of engaging in a point-to-point suborbital space tourism flight through highly engaging marketing materials. There should also be focus on the prestige of engaging in a point-to-point suborbital space flight by demonstrating the exclusivity of participating in the flight. The flight experience should include special articles or events, such as, individualized boarding tickets and fanfare upon boarding the vehicle.

6.3. Limitations and future research

This study has several limitations. First, using Amazon ® Mechanical Turk ®, a convenience sampling strategy, may introduce selection bias. Participants decided to participate after reading the title and explanation of the survey, payment for survey completion, the perceived survey completion time, and other potential motivational factors. Prior studies have, however, shown that Amazon ® Mechanical Turk ® provides results similar to laboratory or offline studies (Buhrmester, Kwang, & Gosling, 2011; Germine et al., 2012; Mason & Suri, 2012; Ramsey, Thompson, McKenzie, & Rosenbaum, 2016). Additionally, sampling bias was reduced through a generic description of the survey so that potential participants could assess the nature of the study without providing enough information to make it more or less attractive to respondents of a particular demographic or characteristic (Goodman & Paolacci, 2017).

Second, our reliance on data collected using Amazon's ® Mechanical Turk ® could potentially limit the generalizability of the results. However, Amazon's ® Mechanical Turk ® has been shown to provide access to a pool of diverse participants across education, demographic and dispositional variables (Mason & Suri, 2012; Mehta et al., 2019; Sheehan, 2018), and prior studies have demonstrated equal internal and external validity when comparing online survey platforms to other convenience samples within the field of applied psychology (Walter, Seibert, Goering, & O'Boyle, 2019). Finally, Amazon ® Mechanical Turk ® provides access to a broad segment of the population, providing the opportunity to increase generalizability with increased external validity (Rice, Winter, Doherty, & Milner, 2017).

Third, additional factors can influence willingness to fly as a suborbital space tourist (Mehran, Olya, & Han, 2023; Musselman & Hampton, 2020; Spector, 2020). This study was isolated to the purpose of assessing the influence of the four dimensions of Iso-Ahola's theory of tourism motivation on willingness to fly as a point-to-point suborbital tourist. Based on the potential influence of age, gender, and annual income as confounding variables, this study included them as control variables. Additionally, research supports motivation, as opposed to risk, as the primary driver for suborbital space tourism, therefore, risk was not added to the model. Finally, research did not support adding other control variables to the model, but as noted in implications for future research section of this paper, future research should assess the influence of other variables on willingness to fly.

Finally, Huan, Beaman, Chang, and Hsu (2008) argue that for some cases of long-tail distribution, especially in tourism research, outlier-attenuation may not be appropriate because this can cause the mean to be biased low. This study attenuated fifteen outliers for annual gross income. These outliers were attenuated based on structural equation modeling procedures described by Hair et al. (2018). Annual gross income was a control variable and is not influenced by and does not influence other variables in the model. Additionally, as analyzed, annual gross income was not significant. Attenuating the fifteen outliers for annual gross is a limitation of this study and could theoretically limit the applicability of this study. Inclusion of these fifteen cases would not, however, appreciably change the results of this study.

Our results suggest additional opportunities for improvement of Musselman and Winter (2023) modified tourism motivation scale. Musselman and Winter (2023) and the pilot study showed acceptable construct validity, but construct validity was less than optimal when the tourism motivation scale was used with the willingness to fly scale. Although this study achieved acceptable construct validity through model respecification, future studies could focus on increased construct validity.

The results of this study further suggest that willingness to fly as a point-to-point suborbital space tourist may be motivated by the

interpersonal escape dimension of tourism motivation. This could be supported by Laing and Frost (2019) identification of freedom and escapism as a key motivation for space travel. They explain this as freedom gained from the pleasure of floating in space based on a hedonic motivational perspective while, paradoxically, recognizing that space travel still requires a considerable amount of control by others. We encourage examination of this relationship in order to see if there is a positive relationship between interpersonal experience and willingness to fly.

Future studies can also investigate the influence that other factors, such as curiosity and individual culture, have on motivation and willingness to fly. Curiosity is motivation to explore and learn about novel, ambiguous, and unfamiliar experiences, which are pleasurable (Christensen, Cotter, & Silvia, 2019; Kashdan et al., 2018; Lowenstein, 1994; Silvia, 2019; Woo et al., 2014). It therefore seems prudent to probe the relationship between curiosity and tourism motivation. In a review of 16 studies, which used Hofstede's cultural dimensions related to tourist behaviors, collectivism and uncertainty avoidance were the predominant cultural dimensions present (Manrai & Manrai, 2011). In general, collectivists' and individualists' tourism motivation differs (Nayeem, 2012; Prebensen, 2005; Risitano, Tutore, Sorrentino, & Quintano, 2017). Similar to collectivism, high and low uncertainty avoidance individuals have different tourism motivations, essentially dichotomous behavior (Litvin, Crotts, & Hefner, 2004; Money & Crotts, 2003). A deeper understanding of individual traits' influence on motivation and willingness to fly can focus marketing and the flight experience.

As control variables, age and gender showed influence on willingness to fly. Existing research on the influence of age and gender on motivation and willingness to fly varies (Baugh et al., 2018; S.C. Chen & Shoemaker, 2014; Crouch et al., 2009; Hill et al., 2015; Jönsson & Devonish, 2008; Kara & Mkwizu, 2020; Li et al., 2013; Mehta et al., 2015; Reddy et al., 2012; Winter & Trombley, 2019; Yousefi & Marzuki, 2015). Future studies could measure the direct effect of age and gender on tourism motivation and willingness to fly as a point-to-point suborbital space tourist. Lastly, future studies could include people from other countries with different cultures. Research shows that people from other countries, including China and the United Kingdom, have an interest in suborbital space travel (LeGoff & Moreau, 2013; The Tauri Group, 2014). Expanding this research could bring deeper insight into various cultures and countries' motivations and willingness to fly. Table 7 summarizes some of these future research suggestions.

In conclusion, we have found specific factors that affect a person's willingness to fly on a point-to-point suborbital flight as a space tourist and developed a new theoretical model of these factors. These theoretical findings support specific actions that the commercial space industry could use to convince people to fly. Informing potential passengers about the adventure and fun of engaging in a suborbital flight, combined with the novelty, prestige, and pride of the flight experience, may help to attract a new group of space travelers.

CRediT authorship contribution statement

Brian T. Musselman: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Visualization, Writing – original draft, Writing – review & editing. **Scott R. Winter:** Conceptualization, Supervision, Validation, Writing – review & editing. **Stephen Rice:** Supervision, Writing – review & editing. **Joseph R. Keebler:** Supervision, Writing – review & editing. **Keith J. Ruskin:** Supervision, Writing – review & editing.

Declaration of competing interest

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