Michelin-starred meal in the stratosphere: scale development of luxury dining on the edge of space

Mohsin Raza, Rimsha Khalid, Hassan Raza, Zahed Ghaderi, Pornpisanu Promsivapallop and Antonio Ariza-Montes

Abstract

Purpose – *Luxury dining is offered over the curvature of the Earth. Deep-pocket dinners will be served by gourmet dining at an altitude of 100,000 feet. Eating a luxury-level meal while gazing out at the curvature of the Earth is about to become a reality, thanks to the collaborative efforts of the luxury dining and space industries. The study responds to a timely call to investigate deep-pocket dinners' perceived space dining experience.*

Design/methodology/approach – *This study developed a multidimensional scale via mixed methodology, incorporating diner reviews, interviews and surveys. The dimensions of the newly developed scale are specified through exploratory factor analysis, confirmed through confirmatory factor analysis and nomological validity is ensured.*

Findings – *Four dimensions of the perceived space dining experience scale were explored via multi-analytic processes, including acute altitude sickness, artificial intelligence failure and cyber threats, mood states (euphoria followed by depression) and sensory perception of flavor.*

Originality/value – *This high-end dining experience features innovative scientific experiments, the complex integration of agentic and generative artificial intelligence, and is likely to provide a once-in-a-lifetime dining experience. The newly developed scale comprehends diners' perceptions at the edge of space.*

Keywords *Artificial intelligence, Luxury dining experience, Space tourism, Mixed methods, Scale development*

Paper type *Research article*

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1. Introduction

Space tourism is a niche segment of the aviation industry that is extremely expensive and attracts ultra-high-net-worth individuals, who total less than one percent of the population. Space tourism encompasses various recreational activities, including lunar tourism, cosmic ray tourism, orbital and suborbital tourism (Stimac, 2021). The concept of space tourism is not as new as it is perceived. Science fiction movies provided us with a plethora of things to think about outer space, robots and artificial intelligence, dating back to the 19th century and even before the development of modern computers. Artificial intelligence helps us expedite the process, and the collaborative robots (cobots) ensure that everything is done in a systematic manner (Schmelzer, 2020). The report of Hern (2016) noted Stephen Hawking's words that artificial intelligence can be proven to be the best thing that happened to us or the worst. The impacts of artificial intelligence on our lives are undeniable, and discussing its role in space is highly relevant. For a long time, humans have continued to send numerous objects, robots, and satellites into the Earth's orbit and space. Although space explorations, experiments, observations and travels involve risky scientific

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experiments, complex procedures and technical operations, artificial intelligence is proving to be an outstanding assistance (Marr, 2023).

Space tourism, dining at high altitudes and enjoying meals while watching a sunrise in the Earth's orbit have been discussed since the 19th century (Smith, 2000; Webber, 2013). However, these discussions and theories became a reality in 2021, when space tourism was officially initiated. Two business giants, including Blue Origin and Virgin Galactic, successfully conducted commercial spaceflights, taking two giant leaps with tourists on board within a 10-day period in 2021. Due to the absence of a commercial space station, the prices are only accessible to ultra-high-net-worth individuals. After that, both companies conducted a few more experimental flights and officially initiated space tourism (Stimac, 2021). The success of space flights attracted entrepreneurs and giant businesses to put their offerings on the table. Chang (2015) says that the demand for space tourism is increasing rapidly, organizations are working to make it more affordable, while tourists are excited about a once-in-a-lifetime experience. It has become a reality over the past few years, opening new frontiers of travel by unlocking niche luxury travel brands.

Space tourism, traveling to the stratosphere and dining over the curvature of the Earth has become a new hype once the Michelin-star hotels and space travel agencies joined hands. Roman Chiporukha, founder of the space tourism company SpaceVIP, announced that they are partnering with acclaimed chef Rasmus Munk and plan to offer the first Michelin-starred experience in space, accompanied by six space diners on board (Gross, 2024). They have received hundreds of applications, but the list of participants has yet to be finalized. The space dining offered by SpaceVIP is for deep pockets only, as the price is set at $500 million (Wass and Bloomberg, 2024). The competition advanced to the next level once the French company offered dining at high altitudes for $130,000. The competition is intensifying through a price war, making it a must-visit vacation spot (Rappaport and Bloomberg, 2023). The tourists will be taken to a height of 100,000 feet, and they will not be sent in conventional rockets, which could hinder their dining experience. Rather, they will be sent by a pressurized capsule, and a space balloon will lift them via technology developed by NASA. These zero-pressure balloon trips to the astronauts' boot camps hit new peaks, and the prices are skyrocketing.

The tourists will be dressed in custom-made outfits by French fashion house Ogier, equipped with onboard Wi-Fi to document the experience, and will be offered a Michelin-star meal. They will enjoy a 98% view of the atmosphere and experience a stunning view of the Earth through large windows. They will see the spherical curve of the Earth while immersing themselves in the darkness of space, away from all light pollution (Madden, 2023). Rabie (2024) clarifies that the sole purpose of this space dining is to provide tourists with a different dining experience that they have never had before. Space tourism companies are also enthusiastic about arranging small events and casual dinner dates in outer space, and the space tourism market is expected to reach 5.19 billion USD by 2034 (Fulco, 2023).

The study of Aguilera (2025) sheds light on the strong integration of machine learning and agentic AI in aerospace, aviation, and space travel. However, Egan (2024) fears that AI cannot be fully trusted as it could stop receiving human commands, make autonomous decisions and become uncontrolled above certain thresholds. Sapkota *et al.* (2025) stresses the need to investigate the AI integration further, as agentic AI, most of the time, operates without human interaction, which can cause serious problems. The study of Richards *et al*. (2023) revealed that there are still gaps that need to be addressed about tourists' safety in space tourism. Further investigation is required to understand the impacts of cosmic conditions on space dinners. Jamal *et al*. (2025) invited future researchers to examine the effects of optimal temperature, AI integration in packaging and perception of healthy food among space tourists. Furthermore, following the call of Liu *et al*. (2022), this study validates the sensory food experience for specific niche segments. Pandith *et al*. (2023) call to investigate the diners' perception at higher altitudes, as tourism companies claim that no exceptional experience or gear is required for space dining. Balasubramanian (2024) fears that space dining or even dining at very high altitudes is not for the faint-hearted, specifically without intensive training. Recently, pop star Katy Perry, along with five other female crew members,

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embarked on an 11-minute space flight to the Kármán line at an altitude of 100 km (Ahlgrim, 2025). The pop star and the other female crew were not obviously astronaut material. Still, they successfully completed their space trip, which affirms the possibility of space travel for nonastronaut tourists (Williams, 2025). However, dining for six hours in space is entirely different and may not be suitable for tourists with acrophobia or other psychological challenges. Therefore, diners' perceptions are crucial to investigate to determine who is ready for this once-in-a-lifetime experience.

This study bridges the information gap by exploring diners' perceptions of the first-ever gourmet in space. In doing so, the primary objective of this study is to develop a scale for assessing the perceived space dining experience and contribute to the literature on space tourism, hospitality and the luxury industry. It further explores the components that can play an essential role in shaping diners' experiences, and by examining the dimensionality of perceived space in dining experiences, the study unveils key determinants that space tourism companies should consider.

2. Literature review

2.1 Space dining experience and well-being: altitude effects, mood swings and sensory disruptions

The space dining experience is trending and pushing the boundaries of culinary innovation. A futuristic concept proposed by Hashem Al-Ghaili, a space dining concept featuring a giant, luxury, nuclear-powered hotel that would fly in space with a capacity of 5,000 passengers, potentially never landing. Such experience has not been witnessed in the hospitality industry (Cosic, 2022). These emerging changes necessitate the need to study the perceived space dining experience extensively, and this scale development is a response to the call by Darma (2022) to examine customer experiences. The space dining experience in this study refers to dining at an altitude of 100,000 feet, which is approximately 30 kilometers. Space technically begins 62 kilometers above sea level, so the Kármán line marks the boundary between Earth and space. A Michelin-starred meal at such a high altitude is referred to as space dining or space tourism. These space tourism capsules will not reach suborbital space, and diners are expected to enjoy the flavors of a Michelin-starred meal in the stratosphere (Rabie, 2024). The flavors are the sensory expression that diners experience while consuming the food (Zmyslony and Wędrowicz, 2019). The flavor involves taste, and it is the gustatory perception of diners representing culture. The unique flavor of food is prepared by combining distinctive ingredients, mixing different elements and applying culinary techniques through novel methods of food infusion, flavor pairing, blending and mixing, which provides a distinct aroma to the food (Spence, 2020). The duality of flavor and smell is one of the most requested attributes of a pleasant dining experience. However, the capacity of diners to perceive the flavor at higher altitudes decreases due to the lack of humidity. The sense of judging fragrance also decreases due to the evaporating nasal mucus of the diners, making it less effective. The low air pressure also affects the sensitivity of the diners' taste buds (Holthuysen *et al*., 2017). Air travelers frequently complain about the taste of food in airplanes at an altitude of 30,000 feet (Lim *et al*., 2024). The study expresses serious concerns that diners who plan to have meals at 100,000 feet could have trouble tasting the food. Considering this case, offering a Michelin-level meal may not be a viable option without preliminary research.

Aeberli *et al*. (2013) investigated the dining disturbance associated with high altitudes through an experiment comparing low-altitude diners with those at high altitudes. Two complementary systems are mentioned that affect customers' emotional states, which are homeostatic and hedonic (Zhang *et al*., 2022). The homeostatic pathways follow the diner's preferences because the key motivation is restoring energy, and the hedonic approach follows a self-reward-based mechanism.

2.2 Technological failure, challenges and risks

Technology, machine learning and artificial intelligence are major players in the space industry. There is, therefore, a unanimous call to investigate artificial intelligence's role in the futuristic

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concept of the space dining experience. Space dining is a fantastic product of human intelligence, combined with advanced technology, AI and machine learning integration, offering adventurous entertainment and sophisticated high-end culinary experiences, all of which are fascinating. The dream of dining in space became a reality once machine learning, a subset of artificial intelligence, assisted space companies. Machine learning is the ability of space machines to imitate the way humans learn and perform tasks autonomously (Kwon and Porter, 2025). Despite its capabilities, machine learning poses security risks that can be exploited by malicious actors, including data poisoning, adversarial attacks and the potential for machine learning models to be used for sophisticated cyber threats (Habler *et al.*, 2025). Therefore, cybersecurity has emerged as a critical requirement in the travel, tourism and hospitality sectors, as digital transformation continues accelerating (Ghaderi *et al.*, 2024). The increasing reliance of space tourism on technologies, including AI, has exposed these industries to a wide range of cyber threats, presenting significant operational and reputational challenges for both businesses and destinations.

Cyber companies are leveraging the third wave of artificial intelligence, known as agentic AI and fascination can quickly turn into a nightmare as agentic AI can make autonomous decisions with limited supervision. The scarier part is its ability to interact with other AI models (Leesa-nguansuk, 2025). Although agentic AI is intended to enhance adaptability and efficiency, its grey side should be investigated. In conclusion, while space dining can be an enjoyable, prestigious and memorable experience, failing to manage technological risks and cyberattacks could pose a significant threat.

2.3 Perceived experience and economic value: dining in space and willingness to pay

The perceived quality of the experience is central to diners' satisfaction and the long-term viability of space tourism. Dining, a core aspect of hospitality, gains new meaning in space, where food preparation, consumption and ambiance must be reimagined. Studies on terrestrial novelty dining (e.g. underwater or themed restaurants) demonstrate how multisensory engagement enhances perceived value and emotional connection (Hjalager, 2010; Tuominen, 2023). In space, constraints related to gravity and safety necessitate innovations such as 3D-printed meals and immersive visuals that simulate Earth or space vistas (Obrist *et al.*, 2019; Santhoshkumar *et al.*, 2024). This experiential uniqueness directly feeds into the willingness to pay a price premium (Choi and Kandampully, 2019). Tourists engaging in space travel are typically affluent individuals seeking novelty, exclusivity and status (Ormrod and Dickens, 2019). Behavioral research suggests that consumers are willing to pay more when experiences are perceived as once-in-a-lifetime, emotionally enriching or story-worthy (deMatos *et al.*, 2024). Furthermore, affective forecasting often leads to many overestimating the joy or prestige gained from such trips, thereby reinforcing their readiness to invest significantly (Wilson and Gilbert, 2005).

To capitalize on this, space dining companies must offer more than just transportation or dining services. They must craft emotionally resonant, sensorially rich and technologically seamless experiences that engage the senses and evoke a sense of wonder (Zhang, 2024). The space tourism industry can justify premium pricing by aligning experience design with psychological insights and sensory science while ensuring long-term diners' satisfaction (Cater, 2010).

3. Methodology

This study develops a measurement scale of deep-pocketed diners' perceived space dining experience. There are two commonly used approaches for scale development, which include a confirmatory factor analysis (CFA) and an exploratory factor analysis (EFA). The study by Orçan (2018) prefers a CFA over an EFA, specifically in a case where the relationships are known. Chang and Hung (2021) endorse the EFA in specifying the scale's dimensionality and Bordbar *et al.* (2021) recommend considering a CFA while developing a multidimensional scale. This study

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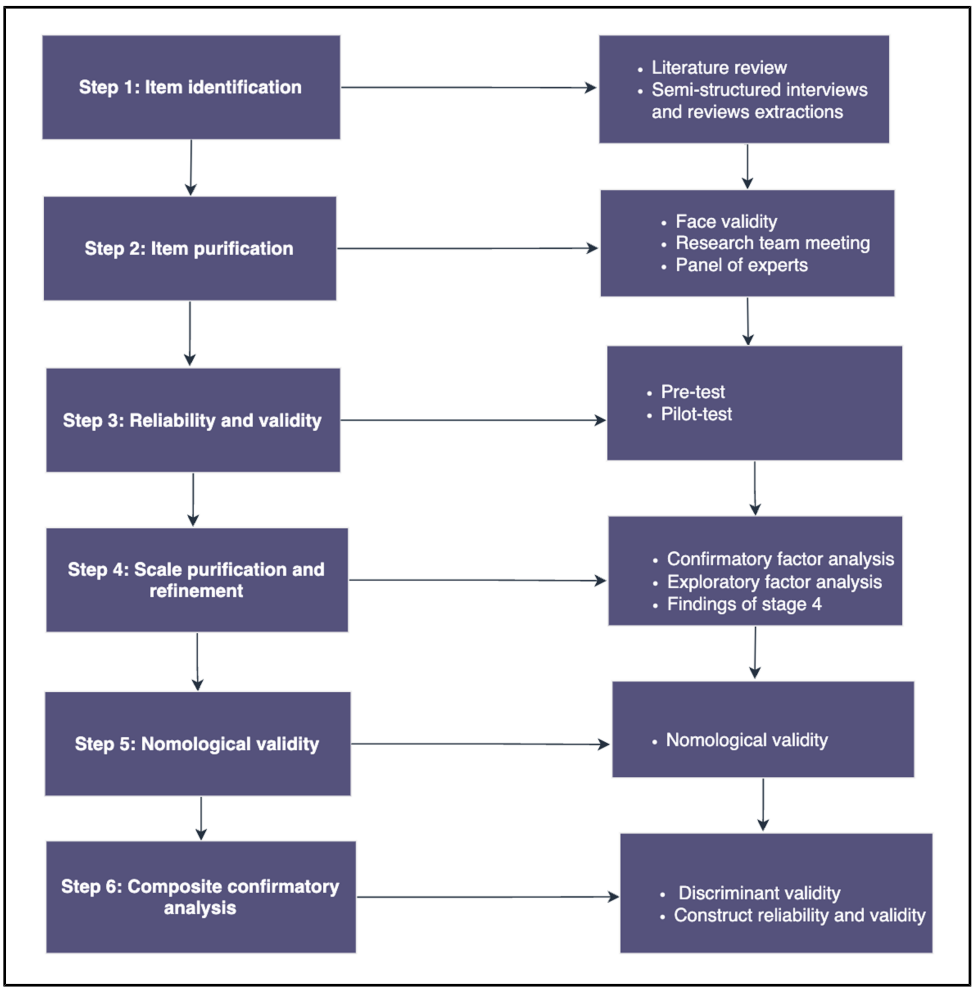
employed the CFA approach to validate the specified dimensions obtained through exploratory factor analysis, as suggested in the previous literature (Bean and Bowen, 2021; Harper and Debb, 2022; Shek and Ma, 2010; Tayal *et al.*, 2021). The scale development process comprises six significant steps that involve diverse activities. The scale development approach follows the procedure mentioned in the studies by Churchill (1979) and MacKenzie *et al.* (2011). However, the steps of scale development are replicated from the study of Dong *et al.* (2024), which are item generation, item purification, reliability and validity, and nomological network and discriminant validity. This study followed the procedure outlined in Figure 1 to develop a multidimensional scale of the perceived space dining experience.

3.1 Step 1: item identification

Step 1. (Activity 1) Literature Review: The process of scale development was initiated by a thorough review of the literature that is related to the hospitality domain. The study employed several keywords to extract information, with the most dominant keywords including space tourism, high-altitude, dining, hospitality, luxury tourism, technology and artificial intelligence. This study extracted the relevant information, the items, and the statements that depict the consequences, impacts and characteristics of the construct. The study employed a narrow research approach, focusing on the top 70 journals in the categories of tourism, leisure and

Figure 1 Scale development and validation steps



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hospitality management, which were retrieved from the Scopus database (Arora and Chakraborty, 2021). This approach enabled systematic research and controlled the large volume of studies (Ferreira *et al.*, 2020).

Step 1. (Activity 2) Online observation.

This phase of activity involved extracting tourists' reviews. The information was gathered from travelers' reviews of high-end dining on social platforms. The review collection focused on dining at high altitudes, including meals on airplanes, luxury dining experiences, Michelin-starred meals and tourists' unique food experiences. The reviews of dinners highlighted their preferences and expectations regarding service delivery (Saydam *et al*., 2022). Once the review extraction was completed, the irrelevant information was filtered, including punctuation marks and all data was converted to sentence case by replacing capital letters with lowercase ones. This dataset comprised 150 reviews (8743 words), and the review extraction process was terminated once the saturation point was reached. The most frequently occurring terms were identified to predict tourists' preferences and were then analyzed using NVivo software (Khan *et al*., 2023). Furthermore, the study followed a step-by-step procedure that included data familiarization, initial code generation, theme search and review, defining and naming, and final report generation (Raza *et al*., 2024).

Step 1. (Activity 3) Semi-Structured Interviews: This activity in the scale development process aimed to conduct semi-structured interviews to extract relevant items. The space dining experience is new to the marketplace. Many organizations have entered the market with their offerings, so a price war has driven prices down. However, the prices still seem to be out of this world, which can only be afforded by deep-pocketed travelers and diners (Wass and Bloomberg, 2024). This study has therefore chosen to interview deep-pocketed travelers to investigate their perceptions about space dining. A total of twenty-four deep-pocketed travelers were approached in Thailand, and nineteen of them were willing to be interviewed. However, two of them canceled the interview at the last minute, so the study further proceeded with seventeen interviews following the nonnumeric questionnaires and obtaining the answers in text form as suggested by Zhang *et al*. (2024). Irrelevant information, such as *"hmm," "umm,"* discussions about unrelated things, and distractions, was ignored, and only the relevant information was proceeded with (Solarino and Aguinis, 2021). The interviews were compiled through NVivo, and approximately 11,000 transcription words were generated and validated using triangulation techniques. The qualitative process consisted of six steps, which included familiarization with the data, code generation, theme search, reviewing themes, assigning names, codes and definitions, and producing the final comprehensive report (Naeem *et al.*, 2023). The study by Jones *et al*. (2021) endorses that the inclusion of a qualitative process needs to be precise in the illumination, which ensures robustness and enhances the conceptualization. Carrying the items generated from the literature, reviews, and interviews, the study further proceeded with the items to step 2.

3.2 Step 2: item purification

The next step in the item purification process followed the item identification, as mentioned in the subsequent steps.

Step 2. (Activity 1) Face Validity: The first activity of step 2 is item purification through face validity. To conduct this step, the extracted items were presented to the respondents who participated in the interview process (Mason *et al.*, 2020). All the interviewees attempted to approach, and five of them agreed to review the extracted items. A few of the items they mentioned as irrelevant and hard for respondents to understand should be removed before proceeding further, and the items with precise meanings and understandable ones should only be kept. The items were retained based on their opinions, considering their appropriateness and relevance.

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Step 2. (Activity 2) Research Team Meeting: The next phase of the study involved a meeting of co-authors. The co-authors organized a meeting to advance the scale development process. After a comprehensive discussion, unclear, repetitive and irrelevant items were removed.

Step 2. (Activity 3) Panel of Experts: After completing the process with the study authors, the researchers further attempted to approach the panel of experts in the field of hospitality to refine the items. Sixteen experts were attempted to approach to further advance this process, and six of them agreed to review the items of the scale. Each expert mentioned a few items that were generic, repetitive and biased; these items were subsequently deleted. Two of the experts mentioned that a few items were not directly related to dining, so these items were removed from the study. The language editor further assisted in improving the items, and a total of 27 items were proceeded with and are presented in Table 1.

3.3 Step 3: reliability and validity

The reliability of the study is ensured via the following procedure.

Step 3. (Activity 1) Pre-Test: The first activity of this step is the pre-testing of the proposed items. The 27 items were sent again to the two native English speakers and three practitioners working in the hospitality field in Thailand. The industry practitioners confirmed that the items meet the criteria and should be proceeded further. However, the native speaker advised incorporating several changes, such as eliminating statements with double meanings, simplifying research terms and correcting biased statements. None of them mentioned any deletion of the items.

Step 3. (Activity 2) Pilot Test: The pilot test was conducted after the pre-testing phase. The questionnaire was sent to 40 respondents, and 31 of them responded. The demographic information was included, and the threshold of values was ensured before proceeding to the next phase.

3.4 Step 4: scale purification and refinement

Step 4 (Activity 1) Exploratory Factor Analysis (EFA): Dinners who have dined in top-notch hotels, enjoyed Michelin meals in Thailand, and visited seven-star hotels were recruited in the year 2024. This study phase returned 218 useable and valid questionnaires. Recommended by Churchill (1979), exploratory factor analysis has been conducted to develop a standard scale for perceived space dining experience. EFA is a popular approach in psychology, hospitality, marketing and tourism to verify the basic structure of variables. Specifically, once the variable is closely related to other variables, the number of possible factors is unclear (Cudeck, 2000). The EFA was performed through SPSS to ensure the number of items and to specify if any dimensions emerged. Kaiser–Meyer–Olkin measured the sample adequacy (KMO = 0.848), and Bartlett's test of sphericity was significant ($p < 0.0001$), ensuring the sufficient correlations of items (Williams

Table 1 Panel of experts

No. of evaluators	*Position and degree*	*Location*	*Specialization/ Interests*
2	Associate Professor, PhD	Malaysia	Business and Tourism
1	Assistant Professor, PhD	Uzbekistan	Business Management
2	Assistant Professor, PhD	Thailand	Event Management
1	Professional Language Editor, MSc	United States of America	Language Expert

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et al., 2010). The study removed items that exhibited communalities below 0.5, and 20 items remained, producing a four-dimensional factor that accounted for variance exceeding the suggested value of 60%. The EFA specified four dimensions that shape the perceived space dining experience, including mood states (euphoria followed by depression), acute altitude sickness, sensory perception of flavor, and AI failure and cyber threats. The direct Oblimin rotation for EFA was followed to identify the structure, and based on an eigenvalue greater than 1.0, dimensions were identified (Pavlicev *et al.*, 2009). The study ensured that factor loadings were higher than 0.6, as items that failed to meet this threshold were removed, as shown in Table 2.

Step 4. (Activity 2) Confirmatory Factor Analysis: To confirm the construct's dimensionality, the study conducted another round of data collection. The questionnaire included a cover letter specifying the objectives and a summarized introduction, and the respondents were assured about their privacy concerns. A CFA was conducted on 304 useable responses via Smart PLS 4 after establishing activity 1. This CFA process confirmed the scale dimensions of the perceived space dining experience, exhibiting an appropriate model fit and loadings, as shown in Figure 2.

Step 4. Findings of Stage 4 (Activity 3): Table 3 presents the composite reliability, loadings and average variance extracted, which meet the threshold criteria outlined in Table 4 (Hox, 2021). Moreover, the degrees of freedom (df), Chi-square (x^2), comparative fit index (CFI), standardized root-mean-square residual (SRMR), root mean square error of approximation (RMSEA) and goodness of fit index (GFI) were also employed.

As per the study of Arasli *et al.* (2020), ensuring the goodness of fit is crucial for the scale development, and the rate of the chi-square to the degrees of freedom should meet the criteria of being below 3. The Chi-square (x^2) value of the study is 448.881, the degrees of freedom (df) is 156 and the value of x^2/df is 2.877 > 2, which satisfies the threshold that is defined by Tabachnick

Table 2 EFA perceived space dining experience (N = 218)

	Factor loadings	*Variance Explained*	*Reliability*
A1	0.828	6.976	0.923
A2	0.835		
A3	0.738		
C1	0.637	15.946	0.9
C2	0.801		
C3	0.878		
C4	0.812		
C5	0.697		
C6	0.626		
C7	0.546		
M1	0.654	10.374	0.887
M2	0.882		
M3	0.687		
M4	0.679		
F1	0.849	40.333	0.921
F2	0.947		
F3	0.718		
F4	0.602		
F5	0.791		
F6	0.931		

Note(s): Extraction method: Principal axis factoring
Rotation method: Oblimin with Kaiser normalization
a. Rotation converged in seven iterations
F=Sensory perception of flavor, C = AI failure and cyber threats, M = Mood states (Euphoria followed by depression), A = Acute altitude sickness

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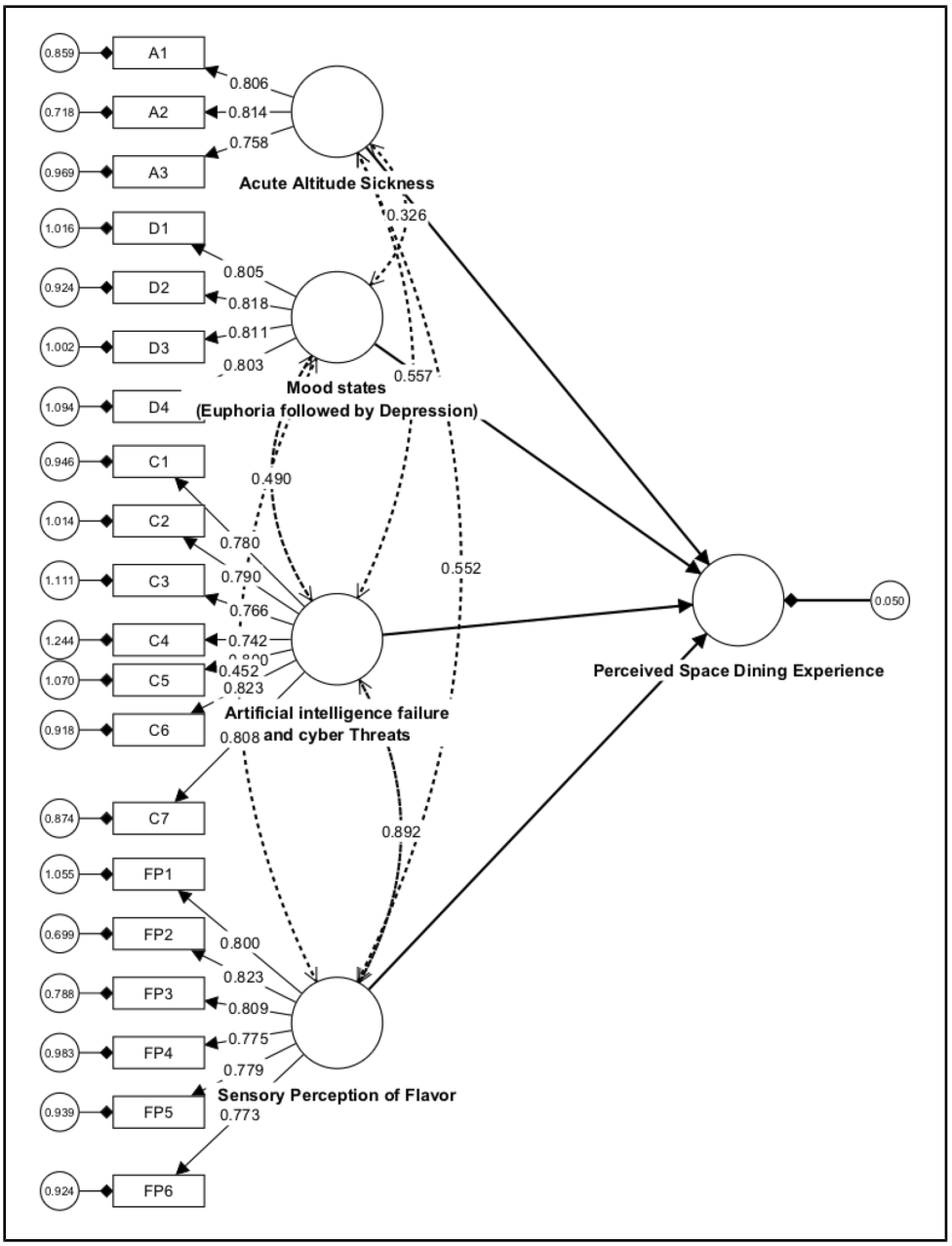
Figure 2 Confirmatory factor analysis



and Fidell (2007), which is also endorsed by the study of Alavi *et al*. (2020). Furthermore, the value that represents the comparative fit index CFI is 0.929 > 0.9, which meets the threshold that was defined by Farooq (2016), the Tucker–Lewis index (TLI) = 0.914 > 9, which is the predefined criteria by Bordbar *et al*. (2021), GFI is 0.862, which meets the expectation by Kim *et al*. (2019), RMSEA = 0.079 < 0.08, which is valid according to Browne and Cudeck (1992) and SRMR = 0.046 < 0.08, which meets the criteria by Hu and Bentler (1999). In addition, Akkuş (2019) stated that if the *p*-value is lower than 0.05 and the value of RMSEA ranges from 0.05 to 0.08, it indicates an acceptable model fit of the developed scale. Furthermore, the reliability and validity of the developed scale are ensured by gauging the appropriate criteria by Hair *et al*. (2021)

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Table 3 Discriminant validity ($N = 315$)

	AI failure and cyber threats	*Acute altitude sickness*	*Mood states (euphoria followed by depression)*	*Perceived space dining experience*	*Sensory perception of flavor*	*Willingness to pay a price premium*
AI failure and cyber threats						
Acute altitude sickness	0.863					
Mood states (Euphoria followed by depression)	0.746	0.846				
Perceived space dining experience	0.99	0.974	0.924			
Sensory perception of flavor	0.866	0.853	0.792	0.988		
Willingness to pay a price premium	0.352	0.324	0.404	0.402	0.406	

Table 4 Confirmatory factor analysis ($N = 304$)

Perceived space dining experience		*CR*	*AVE*	*Loadings*
Acute altitude sickness		0.796	0.566	
A1	I think I may lose my appetite at a high altitude			0.806
A2	I feel uneasy at a high altitude			0.814
A3	I think the dropped oxygen level and pressure can cause nausea, breathlessness and other health issues			0.758
AI failure and cyber threats		0.906	0.581	
C1	The artificial intelligence failure can cause stress among diners			0.78
C2	The proprietary flight system must be highly reliable			0.79
C3	The dinning companies must have alternatives option in case of an artificial intelligence failure			0.766
C4	The technological systems must not have access by third parties			0.742
C5	The cybercriminals can break the spaceship's technological systems			0.8
C6	The over-reliance on artificial intelligence can cause discomfort and fear in diners			0.823
C7	The personal information of the space diners must be well protected			0.808
Mood states (Euphoria followed by depression)		0.814	0.523	
D1	I am excited to join the high-altitude dining experience			0.805
D2	The high altitude triggers the cognitive responses of the diners			0.818
D3	I understand that hypoxia alters the brain functions and mood states			0.811
D4	The high-altitude acclimatization can ruin the dining experience			0.803
Sensory perception of flavor		0.880	0.552	
FP1	I understand the sense of smell reduces at a high altitude			0.8
FP2	The perception of sweetness and saltiness drops at a high altitude			0.823
FP3	The high altitude can make us more sensitive to bitter and sour tastes			0.809
FP4	Lower air pressure affects the sensitivity of the taste buds			0.775
FP5	The fifth flavor pleasant savory taste (umami) is a good choice at a high altitude			0.779
FP6	The aroma, color, flavor and nutrition value of food should be carefully chosen before presenting to diners			0.773

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and Sarstedt *et al*. (2019), and the obtained values are provided in Table 4 along with the measurement items.

3.5 Stage 5: nomological validity

The next phase of the scale development process involves ensuring its nomological validity. The primary purpose of assessing nomological validity is to ensure that newly developed constructs accurately predict relevant concepts based on the provided model (Hagger *et al.*, 2017). Nomological validity is ensured by integrating the nomological variable into the study and testing its validity to confirm that the proposed scale aligns with other variables and contexts (Pollack and Alexandrov, 2013). The study identified a relevant construct from the literature for nomological validity, and this study integrated willingness to pay a price premium as the dependent variable to assess the reliability of the perceived space dining experience. The scale is borrowed from the study of Selem *et al*. (2023) and consists of four items. Another round of data collection was initiated to ensure the reliability and validity of the model fit, and the study obtained 315 usable responses. The variance inflation factor of this study is assured, and there was no evidence of maximum variance on any construct.

3.6 Stage 6: confirmatory composite analysis

The study's model is investigated at a higher order in this phase. The heterotrait-monotrait (HTMT) of the constructs found to be below 1 follows the criteria defined by Henseler *et al*. (2012). Henseler *et al*. (2015) mention further that the HTMT should be based on the study's background and uniqueness. Further, Voorhees *et al*. (2016) argue that HTMT should not be assessed based on conservative benchmarks of 0.85. The study of Roemer *et al*. (2021) endorses values above 0.85 and even close to 1. The HTMT table of the study is provided in Table 3.

Furthermore, the average variance extracted, Cronbach's alpha, and the composite reliability were ensured and presented in Table 5. The structural model assessment revealed significant results for the study's model (Khalid *et al.*, 2025).

4. Discussion and concluding thoughts

The study developed a multidimensional scale of the perceived space dining experience by following the Churchill (1979) paradigm. The study specified dimensions through exploratory factor analysis, confirmed them through CFA and validated the scales by including the nomological variable, the willingness to pay a price premium. The scale was developed using a mixed-method approach, employing interviews, surveys, literature reviews and diner online reviews (Selem *et al*., 2024). The study developed a scale for luxury space dining, which contributes to the luxury hospitality industry. The conceptualization of space dining has undergone significant evolution, influenced by historical sci-fi imaginings and contemporary technological advancements (Stimac, 2021). The successful commercial flights conducted by

Table 5 Reliability and validity ($N = 315$)

	Cronbach's alpha	*Composite reliability*	*Average variance extracted (AVE)*
AI failure and cyber threats	0.909	0.915	0.649
Acute altitude sickness	0.836	0.839	0.752
Mood states (Euphoria followed by depression)	0.846	0.865	0.688
Perceived space dining experience	0.957	0.959	0.553
Sensory perception of flavor	0.91	0.91	0.69
Willingness to pay a price premium	0.845	0.853	0.683

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Blue Origin and Virgin Galactic in 2021 affirmed the sector's commercial viability. Also, they catalyzed the development of unique luxury experiences, such as SpaceVIP's initiative to introduce Michelin-star dining in space (Gross, 2024). As it will be the first of its kind experience, it is crucial to understand the perceived expectations of diners and communicate to them the expected benefits and potential threats associated with space dining. High-altitude dining epitomizes the innovative convergence of aviation, tourism, luxury and hospitality industries by transforming the allure of outer space into an exclusive gourmet experience. Therefore, the study considered it a timely call to develop a scale to understand the perception of diners about this unique gourmet, uncover the potential threats associated with this dining, assess the readiness level of organizations and diners and to understand the preparedness level of organization that offers such dinners and diners who are ready to take leverage of such a fascinating opportunity.

The first identified dimension is acute altitude sickness. Acute altitude sickness arises after spending a few hours at high altitude (Savioli *et al*., 2022). The dinner at the edge of space is gaining new hype, and thousands of people have expressed interest in being one of the first to attend this space dinner. Luxury space tourism companies welcome everyone of any age as the next step. There is no age limit, and no special practices or types of gear are required, which can help alleviate acrophobia and acute altitude motion sickness (Tonkin, 2023). Some people might be fit to fly by airplane, but they may experience acute altitude sickness, because the space dining altitude is three times higher than that of planes. Acute altitude sickness can ruin the dining experience for diners (Aeberli *et al*., 2013). The low air pressure at higher altitudes can result in headaches, nausea, fatigue and even food poisoning. It is almost impossible for space diners to enjoy a great meal at the edge of space, given these severe symptoms (Rovira, 2018). This study therefore recommends adopting precautionary measures and investigating the impacts of higher altitudes on human physiology. Studying how tourists can stay fit at higher altitudes can improve luxury tourism companies' understanding of traveling through cosmic conditions, which may be relevant in the future, as the demand for space travel and dining is outpacing the supply (Balasubramanian, 2024).

The next identified dimension of the newly developed scale pertains to AI failure and cyber threats. Artificial intelligence enhances the dining experience, from automated kitchen processes to personalized services and customer interactions (Kassem, 2024). Technology has significantly altered the hospitality industry during the pandemic, as the industry shifted from a physical to a virtual presence. It seems fascinating to pay and explore the menu via QR codes, get served by robots, and let technological integrations shape the dining experience (Biscotti, 2023; Sawangchai *et al*., 2024). Stephen Hawking warns that artificial intelligence has been proven to be the most significant development we have ever experienced. Still, it can be the worst thing mankind has ever witnessed, turning the memorable experiences into nightmares. Chen *et al*. (2021) further add that artificial intelligence failures are a big part of the space industry beyond the hype.

Luxury space tourism companies are ready to offer an immersive dining experience in space, offering Michelin-level meals. A proprietary flight system will connect the balloon and capsule (Dvorsky, 2022). The design of a spaceship capsule intended for space tourism is kept simple. It comprises two parts: a hydrogen or helium-filled balloon and a space capsule, where tourists are supposed to dine (Heidler, 2023). The co-CEO of Space Perspective Agency stated that Spaceship Neptune, the aircraft designed to transport tourists to space for dining, is safe, remarkably robust, incredibly elegant and luxurious, and the key to safety is simplicity and autonomation (Frearson, 2022). O'Hare (2022) noted that the proprietary flight system will be responsible for keeping the capsule and the space balloon connected, and predicted that conditions will be controlled, which is clear evidence that artificial intelligence failure can bring drastic outcomes that no one wishes for. Luxury space tourism companies assure safety by mentioning that they have worked with NASA and other government agencies on similar projects. However, once software, technology, automation and artificial intelligence are involved,

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cybersecurity concerns always arise. NASA's probe was feared to have been hacked by an unknown party in the past (Hoare, 2020).

A famous saying in the criminology literature, opportunity makes the thief, has received immense attention in the technological literature (Felson and Clarke, 1998). Dining at the edge of space is gaining popularity, so cybercriminals are also ready to exploit this opportunity (Papathanassis *et al*., 2017). The trip will be hosting diners with deep pockets, and the primary agenda of cybercriminals can be accomplished by breaking the spaceship's technological systems and forcing the diners to comply with their demands (Holt *et al*., 2021). The chances of cybersecurity threats are minimal, but cannot be overlooked.

Another identified dimension of perceived space dining experience is mood states (euphoria followed by depression). This study investigates the mood swings and emotional changes at high altitudes, as mood states keep changing as the altitude keeps rising, responding to the call of Das *et al*. (2018). Blood oxygen decreases at high altitudes, which lowers the partial pressure to body tissues (hypoxia) and the body's response to high altitudes. This phenomenon is referred to as high-altitude acclimatization (Bolmont *et al*., 2000). Hypoxia alters brain function, mood states and cognitive responses. The high altitude triggers anger, depression, vigor, mental confusion, fatigue, tension and depressive moods (Lemos *et al*., 2012). Han *et al*. (2019) advocates the role of emotions during the consumption as an essential in affecting dinners' satisfaction, one of the most requested attributes of the dining experience. Kaneko *et al*. (2018) further added that food selection is critical at higher altitudes because it evokes particular emotions. Emotions shape the dining experience, and there is no point in serving Michelin-star-level food if it doesn't trigger euphoria or turns euphoria into depression (Rappaport and Bloomberg, 2023).

Another identified dimension of scale is the sensory perception of flavor, as diners' flavor preferences are of utmost importance in shaping memorable dining experiences. The space dining experience involves feeding tourists and crafting an unforgettable experience for them (Vu *et al*., 2024). It justifies offering Michelin-starred meals prepared by famous chefs for space diners, but the menu is not yet finalized (Steinberg, 2024). Flavor perceptions are usually interlinked with cognitive and sensory aspects. The food comprises a complex mixture of nonvolatile, volatile and irritant component that affects the perceptual impression of diners, which shapes their experience (Forde and Graaf, 2023). Luxury tourism companies plan to arrange for 60 flights to the edge of space each year, aiming to provide diners with the finest hospitality, exquisite dining, immersive experiences, elite designs and premium flavors (Rappaport and Bloomberg, 2023). To understand and address flavor issues at higher altitudes, this study advocates for the integration of artificial intelligence. Bowman (2023) revealed that scientists developed an electric tongue through artificial intelligence programs in the medicine industry that helps them improve the taste of medicine. This AI tongue can be a game-changing innovation in the hospitality industry, helping luxury space tourism companies produce specific flavors of food that diners can enjoy while gazing at the sun over the curvature of the Earth.

5. Implications of the study

The space dining experience seems fascinating and futuristic, a concept that has been discussed for decades and visualized in animated movies. Several attempts have been made to enjoy the dining experience at a high altitude. John Glenn, the first American astronaut, achieved the first successful attempt at space dining, mentioning several factors to consider regarding food preparation and enjoying food at high altitudes (Sawyer, 1998). The study of Balasubramanian (2024) highlighted numerous factors to consider while dining at an altitude of 100,000 ft. The proliferation of these types of luxurious offerings introduces unique challenges. These include navigating the physical and psychological impacts of high altitudes on diners and managing the logistical and technical complexities required to deliver safe and enjoyable experiences in these extreme conditions. Thus, the allure of space tourism and high-altitude dining presents an exciting frontier for the hospitality and tourism industries, so the successful implementation of these types

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of experiences hinges on overcoming significant physical, psychological, logistical and technical challenges. The technological aspect of the offerings is one of the most influential factors that alters diners' experience, because space dining is fueled mainly by artificial intelligence, and the danger of a sophisticated cyber attacker is always on the horizon. These aspects must be expertly managed to ensure space dining can safely and enjoyably take off as a sustainable luxury travel segment.

5.1 Theoretical implications

This study makes a significant contribution to the theoretical aspect by extending the concepts of luxury tourism into the realm of space, offering new perspectives on tourists' behavior, experience design and service delivery under extreme conditions (Rather *et al.*, 2024). The integration of multidisciplinary approaches from gastronomy, aerospace and psychological well-being enhances the depth of analysis, providing a comprehensive evaluation of the high-altitude dining experience (Gabriel *et al.*, 2012).

The research also enriches the literature on the psychology of diners by exploring how unique and extreme environments influence the emotions and satisfaction of diners (Wright, 2023). It specifically explores the significant changes in mood and sensory perception, providing insights into the complex relationship between the environment and psychological states at high altitudes (Das *et al.*, 2018). Moreover, the study highlights the role of artificial intelligence in enhancing traditional hospitality services even in extreme conditions, such as high altitude. This suggests a broader applicability of AI across various sectors of the hospitality industry, promoting innovations that could fundamentally alter how services are delivered (Cozzio *et al.*, 2026). Additionally, the research highlights the critical importance of cybersecurity in the rapidly growing space tourism sector. The study advocates for a proactive approach to technological safeguards by emphasizing the high stakes involved in ensuring the safety and security of operations in space tourism (Dvorsky, 2022).

5.2 Practical implications

The practical implications of this research are extensive and multifaceted. Firstly, ensuring the safety and comfort of the diners is paramount in the nascent field of space tourism. This encompasses rigorous health screenings and the provision of comprehensive medical support to manage the potential risks, such as acute altitude sickness and the psychological impacts of hypoxia, which have profound effects on the body's physiology and mental state at high altitudes (Aeberli *et al.*, 2013; Lemos *et al.*, 2012). Secondly, the issue of flavor perception at high altitudes poses a significant challenge. The sensory experience of dining at altitudes of 100,000 feet can be significantly diminished, which compromises the gourmet quality expected of a Michelin-star meal. Innovations, such as the development of an electric tongue using artificial intelligence, could revolutionize flavor enhancement by ensuring that the dining experience meets the elevated expectations of space tourists (Bowman, 2023). Thirdly, implementing robust cybersecurity measures is crucial, given the significant reliance on advanced technology in space dining. These measures are essential in protecting the integrity of flight systems and the personal data of affluent diners by safeguarding against potential cyber threats that could compromise individual flights, as well as the broader reputation of the luxury hospitality dining brands involved in space tourism.

5.3 Limitations and future scope

The study contributes to novelty by developing a scale for the perceived dining experience in space, identifying research gaps. The following avenues of future research are apparent, given the results of this study. Luxury tourism companies are offering space dining to affluent individuals, and a price war trend is emerging as entrepreneurs intensify the competition in luxury hospitality. It can be anticipated that budget-friendly dining options might be offered in the future, and that

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experience could be an interesting topic. The study investigated diners' perspectives, and future studies may examine the offerings luxury companies provide and how diners' safety is ensured. The study suggested that AI failures and luxury companies should clarify their policies to address the unpleasant situation. Space dining could be risky, and a review of government regulations can be a worthy contribution to the luxury dining literature. A bibliometric investigation of luxury dining is also a timely call. This study gives a unanimous call to validate the proposed scale in diverse contexts. The perceived space dining experience scale was developed by collecting data from Thailand, a country with an upper-middle-income economy. The robustness and appropriateness of the scale can be evaluated by validating it in high-income states.

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