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Discovering the Potential Impact of In-Flight Smart Amenities on Traveler Experience: Focal Roles of In-Flight Service Quality and Airline Endorsement

Nermen Elsayed Mohamed Mohamed Elhattab

The Higher Institute for Tourism and Hotels - El Seyouf – Alexandria

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The service quality provided and traveler endorsement of a particular airline over another may play crucial roles in explaining the inherent relationship between smart amenities and creating an immersive experience for air travelers. In this regard, 487 potential travelers were obtained via Egyptian Airlines, whether travelling from or coming to Egypt. SmartPLS 4 results revealed that intelligent seats, smart overhead bins, and an in-flight entertainment system significantly affected service quality on board. Besides, in-flight service quality positively affected traveler experience. Furthermore, in-flight service quality partially mediated the association between intelligent seats and traveler experience, while fully mediated the linkages between traveler experience and both smart overhead bins and in-flight entertainment system. Lastly, airline endorsement strengthened the positive association between in-flight service quality and traveler experience in favor of the Egypt Air sample. This paper highlights the effective contributions of decision-makers in the tourism and travel industry regarding the possibility of developing airlines for travelers, whether for business or leisure, as well as equipping aircraft with emerging technologies such as IOT-enabled smart glasses and Metaverse-enabled travel apps.

1. Introduction

In the contemporary tourism realm, the ubiquity of digitalization is undeniable (Volo & Irimiás, 2022). However, it is imperative to recognize that digitalization alone does not inherently confer a competitive edge. Its true power lies in the indirect enhancements it can offer to a company's products and services (Oliveira et al., 2019). Decision-makers are poised to harness digitization's potential to fortify their company's internationalization strategy, with the overarching goal of expanding their customers base by enhancing their offerings quality (Heiets et al., 2022). As such, integration not only empowers the tourism industry with a profound understanding of competitive dynamics but also delves deeper into customer preferences (IATA, 2020).

Within this landscape, airlines take center stage, offering a plethora of digital services. It is abundantly clear that customer satisfaction hinges directly on the quality and personalization of these offerings (De Crescenzio et al., 2021). By comprehending their customers' needs, airlines can provide high-quality services (Khallaf et al., 2022). Indeed, aviation and tourism sectors have prominently positioned themselves as early adopters of innovative and emerging technologies (Salesi et al., 2021). This strategic integration not only equips the industry with competitive dynamics but also facilitates a more profound exploration of intricate customer preferences (IATA, 2020). These cutting-edge technologies hold promises of not only elevating customer experiences but also ushering in substantial enhancements in operational efficiency, establishing competitive advantages (Heiets et al., 2022).

Passenger preferences in choosing airlines are influenced by factors such as pricing, safety, loyalty programs, service quality, in-flight entertainment, and baggage handling, with increasing importance placed on in-flight comfort (Law et al., 2022). Airlines are responding to fierce competition by improving plan cabin interiors to imrove passenger comfort (Kavus et al., 2022). Intelligent aircraft cabins are introducing innovative solutions to address previous discomfort issues, paving the way for the development of "smart planes" that can streamline cabin operations and elevate passenger experience through features like intelligent overhead compartments, dimmable windows, smart services, and state-of-the-art, high-definition, zero-touch entertainment screens (De Crescenzio et al., 2021).

In an era of growing digitalization, passengers increasingly desire autonomy and personalization during their flights. Thus, integrating design enhancements such as personalized light controls and adjustable seating into aircraft cabin interiors become paramount to elevating the overall in-flight passenger experience (Bouwens et al., 2018). Munoz et al. (2019) have emphasized that enhancing traveler experience is a strategic avenue for the air transportation industry to boost profits. Consequently, airlines and airports alike are redirecting their efforts toward improving service quality and ensuring traveler satisfaction (De Crescenzio et al., 2021). Marketing managers within these sectors are diligently evaluating the holistic experience of air travelers to gauge their performance.

While prior research has delved into the focal role of innovative solutions on traveler experience, these studies often focused on specific technological trends (Oliveira et al., 2019). For instance, La et al. (2021) explored the value passengers place on in-flight entertainment systems. Williamson et al. (2019) ventured into passenger attitudes regarding social acceptability using VR. Accordingly, Figure 1 illustrates that the association between in-flight smart amenities and traveler experience appears to be implicit, thus the mediating role of in-flight service quality and the moderation effect of airline endorsement can be explored.

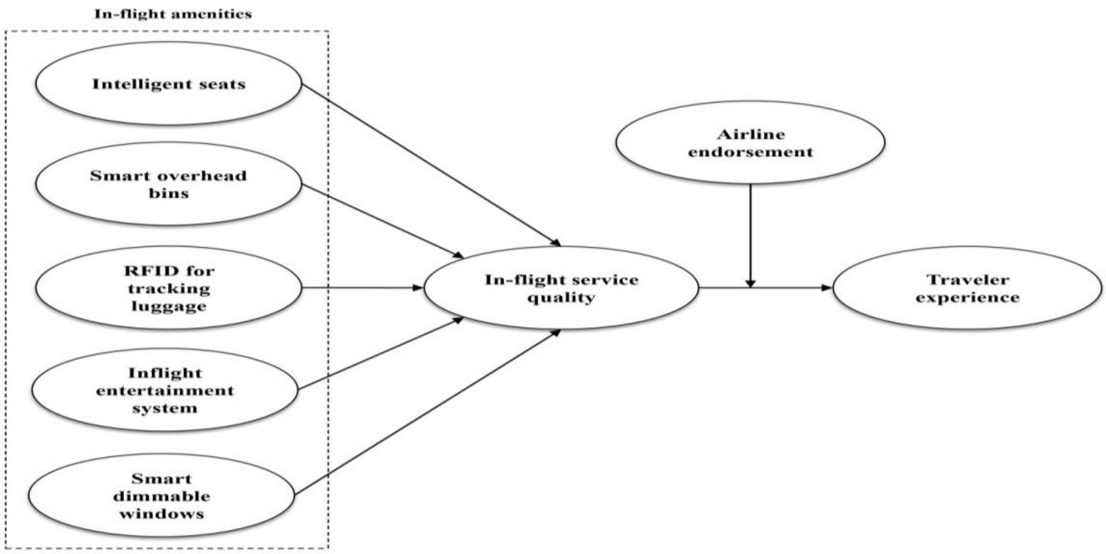


Figure 1. Proposed model.

2. Literature review

2.1. In-flight smart amenities

The level of comfort experienced within the aircraft's interior significantly influences a passenger's likelihood of choosing the same airline for future flights (Moerland-Masic et al., 2022). To elevate passenger experiences, the concept of the digital cabin has been introduced (Soonthodu et al., 2022). This innovative approach encompasses a holistic integration of aircraft components, including engine performance and the in-flight entertainment system, which are interconnected and monitored in real time. By embracing the concept of digital cabins, passengers are empowered with greater control over their immediate surroundings (Dwivedi et al., 2022). This elevated level of personalization contributes significantly to a more enjoyable and satisfying travel experience for passengers (Ninnemann et al., 2022).

Moreover, the future of meal service during flights envisions the adoption of smart, vending machine-style ordering systems driven by technological advancements (Campos et al., 2022). Passengers will be able to use mobile apps to select their meals and collect them, along with additional amenities like travel pillows and headphones, directly from the galley when they are ready (De Crescenzio et al., 2021). A case in point is the A380 Super Jumbo, which utilizes a radio frequency identification (RFID) tag system. RFID empowers passengers to individually order meals through seat-mounted touch screens and receive their heated orders promptly during designated meal times using inductive ovens (Buhalis et al., 2022). Such innovative approaches streamline service operations, ultimately enhancing the overall passenger experience (Campos et al., 2022).

2.1.1. Intelligent seats

Intelligent seats are designed to enhance passenger comfort by adjusting to their movements, weight, size, and temperature through material tension adjustments (Zhou et al., 2022). They also connect to passengers' smartphones, allowing them to customize settings for sleep, meal times, and massages (Soonthodu et al., 2022). During the flight, seats automatically adapt to passenger weight, size, and movements, effectively addressing issues related to legroom discomfort caused by excessive seat reclining (De Crescenzio et al., 2021).

2.1.2. Smart overhead bins

Utilizing sensor-equipped smart overhead compartments linked to an aircraft's IoT system can significantly speed up boarding (Rappa et al., 2022) by minimizing passenger time spent searching for storage space (Salesi et al., 2021). Airbus has introduced a color-coded system to indicate compartment occupancy: red for full, green for sufficient luggage space, and yellow for small items like clothing (Rath & Chow, 2022). This innovation enhances boarding efficiency and reduces stress for both passengers and flight attendants (Moerland-Masic et al., 2022).

2.1.3. RFID for tracking luggage

Baggage mishandling has consistently been a significant source of passenger dissatisfaction within the airline industry (IATA, 2019). In response to this challenge, IATA has identified RFID as an emerging technology with the potential to substantially reduce incidents of lost luggage, offering a multitude of advantages to the tourism industry (Hassan & Rahman, 2022). RFID technology implementation holds the promise of not only enhancing customer service but also delivering cost reductions, streamlining operational efficiency, and minimizing human errors and labor requirements (De Crescenzio et al., 2021; Salesi et al., 2021).

RFID technology adoption in airport operations has ushered in remarkable improvements in luggage tracking, significantly enhancing customer satisfaction (Salesi et al., 2021). One notable application of RFID is electronic baggage tags (De Crescenzio et al., 2021), providing travelers with means to monitor whereabouts of their luggages through a user-friendly mobile phone app, typically employing Bluetooth connectivity (Rajapaksha & Jayasuriya, 2020). This innovation has brought substantial enhancements to passenger experience, offering real-time visibility into the status of their belongings (IATA, 2019). Delta Air Lines has emerged as a trailblazer in harnessing RFID technology to address the persistent issue of lost luggage.

Through their innovative Delta Mob app, passengers traveling with airlines receive timely notifications when their baggage is successfully loaded onboard (Soonthodu et al., 2022). In the rare occurrence of inadvertent misplacement, Delta can swiftly pinpoint the luggage's location within its system. This feat is accomplished through the use of belt loaders equipped with indicators that display proper baggage loading with a green light or signal a need for additional attention with a red light (De Crescenzio et al., 2021). Delta's proactive approach serves as a prime example of the substantial potential of RFID technology in not only improving baggage handling but also elevating overall passenger satisfaction (Rajapaksha & Jayasuriya, 2020).

2.1.4. In-flight entertainment system

The latest generation of in-flight entertainment systems has ushered in a remarkable transformation in the air travel experience (Stankov et al., 2022). These cutting-edge systems offer passengers an extensive array of entertainment choices, encompassing video, audio, games, and music, effectively mitigating the weariness associated with travel (De Crescenzio et al., 2021). Patel and D'Cruz (2018) underscore that flight entertainment systems stand second in importance only to seat comfort and legroom. It serves as a means for passengers to remain engaged during flights, serving as a distraction, alleviating travel fatigue, addressing health concerns related to air travel (Williamson et al., 2019), as well as instilling trust in airlines and nurturing passenger loyalty (Stankov et al., 2022). Recent studies have shown that premium in-flight services, including access to the latest movies and Wi-Fi connectivity, wield significant influence over travelers' ticket choices, contributing to heightened customer satisfaction (Jin & Kim, 2022; Soliman et al., 2022).

The inception of in-flight entertainment systems was primarily rooted in enhancing passenger comfort during long-range flights, chiefly by providing food and beverages (Salesi et al., 2021). However, in-flight entertainment systems have undergone a remarkable evolution in response to escalating passenger expectations, intensifying competition among airlines, and rapid technological advancements. Modern electronic devices have emerged as catalysts in this transformation, broadening the horizons of in-flight entertainment systems to offer a diverse range of services (Rajapaksha & Jayasuriya, 2020). The core concept behind in-flight entertainment systems has evolved from simply providing physical comfort to actively engaging passengers in the entertainment process (Stankov et al., 2022). These systems have further expanded to encompass business-related services through connectivity tools and even serve as platforms for monitoring passengers' health and promoting their psychological well-being (De Crescenzio et al., 2021).

Passengers now enjoy a plethora of activities at their fingertips onboard, ranging from shopping, gaming, and listening to recorded music or music channels to reading e-books or newspapers and even requesting assistance from the cabin crew (Spasojevic & Lohmann, 2022). All of these activities are easily accessible through a user-friendly handset or touchscreen interface. Cabin crew and pilots can effectively communicate with passengers through internal cabin speakers made audible through a remote jack unit (De Crescenzio et al., 2021). Facilitating this seamless experience, the Seat Electronic Box serves as the intermediary connecting the handset and the monitor (Chan & Li, 2022). Meanwhile, essential data, such as videos, movies, and announcements, are sourced from the HDD Onboard Media Loader. This sophisticated system operates continuously, ensuring passengers have uninterrupted access to these services throughout their flight (Paguinto et al., 2022).

The introduction of zero-touch technology has taken the in-flight entertainment system experience to the next level (Rajapaksha & Jayasuriya, 2020), allowing passengers to effortlessly connect their personal electronic devices to the seat-back in-flight entertainment screens via Wi-Fi and QR code scans. This innovation empowers passengers to control and access the airline's in-flight entertainment offerings using their own devices. Additionally, the tourism industry has harnessed VR technology to enhance various aspects of passenger experience, including addressing the fear of flying (Wallius wt al., 2022). Airlines have initiated trials to introduce in-flight VR, providing passengers with immersive entertainment during their journeys (Moerland-Masic et al., 2022).

Alaska Airlines (2018) conducted trials of VR for first-class passengers, aiming to create a private movie theater-like experience. The Spanish flag carrier, Iberia, embarked on a successful six-month trial of in-flight VR in both business and economy class on select routes, receiving positive feedback from customers regarding usability and satisfaction. The resounding success of the initial trial prompted Iberia and in-flight VR to expand the implementation to the entire business class (De Crescenzio et al., 2021).

2.1.5. Smart dimmable windows

The realm of energy-efficient technology is embracing a promising innovation in the form of smart windows, distinguished by their electrochromic properties that enable dynamic shading adjustments while maintaining impeccable visibility (De Crescenzio et al., 2021). A wealth of research papers have delved into this transformative technology, illuminating its vast potential to not only bolster energy efficiency but also enhance passenger comfort through dynamic control and seamless integration with IoT (Hirani, 2022). Smart windows can seamlessly integrate into heating, ventilation, and air conditioning systems or function independently as stand-alone systems (Godoy & Schierloh, 2022).

The landscape of technologies explored in this domain frequently encompasses devices equipped with finely-tuned control algorithms that meticulously balance energy efficiency and visual comfort considerations (Salesi et al., 2021). These systems may even incorporate innovative predictive models for short-term solar radiation incidence, often leveraging cutting-edge techniques like sky scanning, all while accommodating individual user preferences (Gonzalez et al., 2018). In a notable development, Boeing (2021) introduced a groundbreaking feature in their aircraft known as smart, electronically dimmable windows. These ingenious windows empower passengers with the ability to effortlessly regulate the amount of incoming light within the cabin with a simple press of a button.

The allure of smart dimmable windows lies in their capacity to preserve captivating exterior vistas while effectively mitigating unwelcome glare, elevating the overall in-flight experience for passengers (Zakirullin, 2022). A noteworthy departure from conventional manual window shades, passengers aboard the new A350 aircraft can conveniently tailor their window shade settings at their fingertips, ushering in unparalleled ease and comfort during their journey (Boeing, 2021).

2.2. In-flight service quality

Airlines enhance passenger satisfaction and competitiveness by integrating digital technologies, as success in this highly competitive industry depends on perceived service quality (Kavus et al., 2022). Therefore, digital technology adoption is crucial for positively influencing passenger satisfaction, service quality, and passenger recommendations, ultimately bolstering an airline’s competitive position and attracting a larger customer base (Shen et al., 2022). The futuristic "smart plane" concept has potential to enhance customer experience in various ways (Shiwakoti et al., 2022). Therefore, this paper assumes that:

H1. Intelligent seats positively affects in-flight service quality.

H2. Smart overhead bins positively affect in-flight service quality.

H3. RFID for tracking luggage positively affects in-flight service quality.

H4. In-flight entertainment system positively affects in-flight service quality.

H5. Smart dimmable windows positively affect in-flight service quality.

2.3. Traveler experience

Passengers on an aircraft assess and judge the services provided by comparing their expectations to their actual experiences (Kavus et al., 2022). To put it simply, passenger satisfaction derives from enjoyable in-flight services, which tends to increase their intention to use the airline’s services again (De Crescenzio et al., 2021). Therefore, it can be inferred that in-flight services have a significant impact on passenger experience (Rajapaksha & Jayasuriya, 2020), and this paper assumes that:

H6. In-flight service quality positively affects traveler experience.

In the realm of air travel, passenger experiences have been independently examined concerning airline services (Kavus et al., 2022). Additionally, air carriers have recognized the significance of airline service quality in influencing traveler satisfaction and loyalty (Spasojevic & Lohmann, 2022). Conversely, research on airport service quality has identified various factors contributing to overall travel experience, including security measures, servicescape, shopping and dining options, luggage policies, and facilities (Lee & Yu, 2018). Therefore, this paper assumes that:

H7. In-flight service quality mediates the association between traveler experience and a) intelligent seats, b) smart overhead bins, c) RFID for tracking luggage, d) entertainment system, and e) smart dimmable windows.

2.4. Airline endorsement

The significance of airline service quality cannot be overstated; it stands as a defining factor in travelers' choices of airlines (Rajapaksha & Jayasuriya, 2020). Exceptional in-flight service, in particular, plays a pivotal role for airlines in the fiercely competitive aviation landscape (Rappa et al., 2022). In this intricate realm, the metric of customer perception emerges as a potent tool, surpassing other performance indicators (Lee & Yu, 2018). Customers hold the true authority in evaluating service quality within the tourism sector (Nguyen et al., 2022). Customers' perception of services is not merely an isolated event (Kavus et al., 2022); it has the power to propagate through the realm of positive word-of-mouth recommendations, significantly impacting an airline's reputation and customer base (Rajapaksha & Jayasuriya, 2020). Therefore, this study assumes that:

H8. Airline endorsement moderates the association between in-flight service quality and traveler experience.

3. Method

3.1. Research design

To authenticate the survey's content, a panel of eight academic experts in Egypt's tourist marketing was enlisted. Thus, they acknowledged the questionnaire's clarity in terms of its primary goal and readability while recommending minor changes to the in-flight service quality questions to concentrate more on the onboard smart facilities. Hence, these recommendations were taken into consideration. By posting the survey link on Twitter and Facebook sites for Egypt tourism, potential travelers on Egyptian Airlines were attracted. Thus, a pilot test was conducted with 70 such travelers using Survey Monkey.

During this stage, 57 voluntary responses were gathered via the author's email. As a result, they included succinct remarks to make the items as simple as possible and to aid in understanding certain particular issues related to using smart technologies in in-flight services for different travelers. As a result, their suggestions were taken into account before the dataset was actually collected.

3.2. Data gathering

Purposive sampling was used to obtain data from prospective Egyptian Airlines (e.g., Air Memphis, Air Cairo, Fly Egypt, Egypt Air, Alexandria Airlines) passengers who were older than 21 and had at least a bachelor’s degree as the unit of analysis. This age group was chosen due to their ability to understand this paper’s nature and the lack of bias in choosing answers or choosing a unified answer for all items. Further, we focused on holders of a bachelor's degree as an academic degree because there are some terms that are difficult for high school or primary school holders to understand easily, which raises suspicions that some measurement errors or potential response bias may occur.

Between 10-29 May 2022, 800 online copies of a self-administered questionnaire were given. Of those, 628 completed responses were obtained. As such, 74 responses were eliminated from the target sample since their participants’ ages were below 30 and they had a high school education or equivalent. As a result, they did not meet the two aforementioned requirements. Using advanced technology in SPSS 28, it was found that there were 67 responses that had outliers or stable answers on one option for all questionnaire items or ended the questionnaire within less than a minute.

Therefore, these responses were completely removed so as not to affect the advanced data analysis and produce biased results. As such, the final sample was 487 after exploring whether or not it was adequate for blind analyses using G*Power. The results resulted in a power value of 99%, that is, greater than 80%, with an effect size exceeding 0.50 using six predictors, which confirms the validity of the sample for repeated testing.

3.3. Instruments

To gauge in-flight service quality, eight items were modified from Namukasa (2013) in this paper. Five items were employed to assess traveler experience derived by Hoyer et al. (2020). Airline endorsement was gauged with three items cited from Chih et al. (2020). To assess in-flight smart amenities, 17 items were cited from De Crescenzio et al. (2021) with five sub-scales: intelligent seats (three items), smart overhead bins (three items), RFID for tracking luggage (three items), smart dimmable windows (three items), and in-flight entertainment system (five items). All items were graded on a 7-point Likert scale, where 1 represents "strongly disagree" and 7 represents "strongly agree."

For self-reported surveys, methodological procedures have been put in place to reduce common method variance (CMV): 1) subjects were psychologically disassociated from anticipating a cause-and-effect relationship and 2) respondents’ information confidentiality was disclosed to them. Last but not least, the marker-correlation method was employed to see how it affected the dataset. Since dark triad traits served as the marker variable, PLS analysis revealed that the absence of significant differences in whether or not this variable was added proved the model’s ability to predict. Therefore, there is no CMV in our dataset.

3.5. Analysis approach

Testing a certain conceptual model is the main goal of PLS (Shmueli et al., 2019), which examines several regression equations. In contrast to CB-SEM, which is based on maximum likelihood, PLS is a nonparametric statistical approach (Hair et al., 2022). As a result, Cheah et al. (2019) noted that PLS-SEM works with non-normally distributed data. Further, the sample size in PLS-SEM is influenced by a number of indicators for each construct and calculated parameter. Because of this, the majority of academics should not be concerned with the maximum sample size (Sarstedt et al., 2022). In response to this argument, Smart PLS 4.4 was run to conduct a two-step data analysis: 1) an outer model and 2) an inner model.

4. Findings

4.1. Respondents' information.

Table 1 lists respondents' characteristics, using SPSS28 as follows:

Table 1. Demographic information (N = 487).

Category	Frequency	%
Gender		
Male	229	47
Female	258	53
Average annual expenditure		
Below 40k L.E.	184	37.8
40k-69k L.E.	202	41.5
Above 70k L.E.	101	20.7
Traveler generations		
Baby boomer	125	25.7
Millennials	153	31.4
Generation Z	209	42.9
Travel purpose		
Entertainment	184	37.8
Business	303	62.2
Any Egyptian airline like?		
Air Memphis	86	17.7
Air Cairo	60	12.3
Fly Egypt	116	23.8
Egypt Air	165	33.9
Alexandria Airlines	60	12.3

Of 487 respondents, 53% were female and 47% were male, which indicates that the groups most tendency to air travel are women. According to average expenditure, 41.5% of respondents spend 40 to less than 70 thousand Egyptian bounds per year, followed by 37.8% of those who spend below 40 thousand Egyptian bounds per year. This indicates that the expenditure rates of passengers on Egyptian Airlines appear relatively high. Regarding traveler generations, 42.9% were baby boomers, followed by 31.4% were millennial. This confirms that most travelers are elderly people.

Further, 62.2% of participants travel to business, while only 37.8% travel to entertainment. This points out that air travel via Egyptian Airlines focuses more on the business sector. Lastly, participants' preferences for traveling across Egyptian airlines ranged as follows: 33.9% preferred Egypt Air, 23.8% preferred Fly Egypt, 17.7% preferred Air Memphis, and 24.6% in total preferred both Air Cairo and Alexandria Airlines. This confirms that Egypt Air is considered the leading company in air travel to and from Egypt.

4.2. Outer model

Using SPSS28, findings showed that all items fall between a medium and high degree in their average and deviate slightly from this average, as shown in Table 2.

Table 2. Convergent reliability and validity.

Constructs	Code	Items	M	SD	Loadings	AVE	CR
In-flight service quality	ISQ1	This airline makes me feel secure when I fly.	4.51	1.699	.783	.606	.925
	ISQ2	The cabin and chairs are spotless and comfy.	4.35	1.603	.762		
	ISQ3	This airline's employees look well-groomed.	4.44	1.583	.762		
	ISQ4	This airline served delicious food.	4.45	1.672	.761		
	ISQ5	The pleasant, multilingual cabin personnel of this airline are impressive.	4.36	1.444	.773		
	ISQ6	The airline constantly offers excellent in-flight services.	4.19	1.873	.802		
	ISQ7	I was pleasantly surprised by my in-flight encounters with this airline.	4.21	1.771	.795		
	ISQ8	This airline provides excellent in-flight amenities at a reasonable price.	4.41	1.682	.790		
Traveler experience	TEX1	The airline was a great experience, in my opinion.	4.67	1.551	.887	.793	.950
	TEX2	I think this airline offers a better experience than others.	4.61	1.642	.879		
	TEX3	I believe the entire airline experience has been wonderful.	4.64	1.589	.912		
	TEX4	I often feel satisfied after flying with this airline.	4.60	1.527	.888		
	TEX5	I think this airline is aware of the kind of experience its passengers desire.	4.54	1.602	.886		
Airline endorsement	AEN1	This airline showcases great services for its travelers.	4.75	1.518	.778	.605	.821
	AEN2	I may use this airline.	4.85	1.497	.757		
	AEN3	This airline piques my interest.	4.94	1.567	.799		
Intelligent seats	INS1	I want to use sensor-equipped intelligent chairs onboard.	4.88	1.495	.768	.633	.838
	INS2	My experience of in-flight travel will be enhanced by the futuristic intelligent chairs with sensors.	4.85	1.457	.825		
	INS3	I am willing to spend more to use intelligent chairs onboard.	4.75	1.462	.792		
Smart overhead bins	SOB1	I will locate available luggage space thanks to clever overhead containers onboard.	4.44	1.604	.757	.599	.817
	SOB2	Smart overhead bins will save	4.61	1.612	.773		

		boarding times and ease aisle congestion onboard.					
	SOB3	I am considering employing intelligent overhead bins onboard.	4.46	1.556	.791		
RFID for tracking luggage	RTL1	RFID will boost my trust in the airline's ability to handle my bags.	4.37	1.696	.797	.635	.839
	RTL2	When it comes to tracking my luggage, I'm interested in using RFID tag for this airline.	4.62	1.618	.792		
	RTL3	For using RFID tag, I am willing to pay additional fees for this airline.	4.31	1.612	.801		
Smart dimmable windows	SDW1	Using smart, dimmable windows while flying is something I am interested in at this airline.	4.35	1.614	.788	.596	.816
	SDW2	Intelligent dimmable windows will significantly enhance my in-flight experience at this airline.	4.63	1.532	.783		
	SDW3	Dimmable windows touch button's ability will enhance my experience at this airline.	4.59	1.500	.744		
In-flight entertainment system	IES1	I want to use the 4K Clarity Zero-Touch inflight entertainment.	4.71	1.505	.854	.735	.933
	IES2	VR-in-flight is something I am interested in.	4.87	1.463	.863		
	IES3	This airline, which deploys VR on flights, has a tremendous pull.	4.74	1.596	.854		
	IES4	I will divert my attention from a painful circumstance with VR onboard.	4.60	1.584	.858		
	IES5	The 4K Clarity Zero-Touch in-flight entertainment screen piques my attention.	4.73	1.527	.858		

According to Hair et al. (2022), Table 2 demonstrates that all items have factor loadings above the acceptable upper range of 0.70, indicating that the metrics used are distortion-free. To establish convergent validity, average extracted variance was assessed with values exceeding 50% (see Table 2). According to Hair et al. (2022), composite reliability values had values over 0.70, implying all scales consistency with their subscales (see Table 2). Accordingly, the model was reliable and had sufficient convergent validity.

Table 3. Discriminant validity (HTMT).

Constructs	1.	2.	3.	4.	5.	6.	7.	8.
1. Airline endorsement								
2. In-flight entertainment system	.102							
3. In-flight service quality	.426	.116						
4. Intelligent seats	.346	.097	.480					
5. RFID for tracking luggage	.050	.175	.086	.019				
6. Smart dimmable windows	.038	.170	.056	.007	.207			
7. Smart overhead bins	.019	.046	.204	.079	.074	.050		
8. Traveler experience	.067	.015	.165	.089	.057	.147	.200	

Furthermore, HTMT findings in Table 3 demonstrated that no construct had a significant value greater than 0.85 (Cheah et al., 2019). This indicated that discriminant validity was strong.

4.3. Inner model

Hair et al. (2022) asserts that f^2 values show appropriate impact levels for the endogenous latent scales.

Table 4. Hypothesis testing results.

Direct effects						
H	Paths	β	*t*-value	p-value	f^2	Supported?
H1	Intelligent seats → In-flight service quality	$.480^{***}$	12.055	.000	.305	Yes
H2	Smart overhead bins → In-flight service quality	$.204^{***}$	4.592	.000	.186	Yes
H3	RFID for tracking luggage → In-flight service quality	.086	1.902	.058	.009	No
H4	In-flight entertainment system → In-flight service quality	$.116^{*}$	2.567	.011	.093	Yes
H5	Smart dimmable windows → In-flight service quality	.056	1.244	.214	.004	No
H6	In-flight service quality → Traveler experience	$.165^{***}$	3.685	.148	.000	Yes
Mediation effects						
H	Structural paths	β	*t*-value	p-value	95%CI	Decision
H7a	Intelligent seats → In-flight service quality → Traveler experience	$.076^{*}$	2.448	.028	.015, .137	Partial mediation
H7b	Smart overhead bins → In-flight service quality → Traveler experience	.034	1.346	.053	-.015, .083	Full mediation
H7c	RFID for tracking luggage → In-flight service quality → Traveler experience	.014	.443	.078	-.049, .077	No-mediation
H7d	In-flight entertainment system → In-flight service quality → Traveler experience	.019	.684	.062	-.044, .044	Full mediation
H7e	Smart dimmable windows → In-flight service quality → Traveler experience	.009	.298	.219	-.052, .070	No-mediation

According to Table 4's findings, f^2 values exceeded 0.15, indicating medium effect sizes for the predictor variables in the dependent variable, except for some values that were less than .02, implying there is no effect of predicators on outcome constructs. As such, Table 4 proved that in-flight service quality was positively affected by intelligent seats (β = .480, t = 12.055, p < .001), smart overhead bins (β = .204, t = 4.592, p < .001), and in-flight entertainment system (β = .116, t = 2.567, p < .05), supporting H1, H2, and H4. Otherwise, RFID for tracking luggage had not significant effect on in-flight service quality (β = .086, t =

1.902, p > .05), rejecting H3. Likewise, smart dimmable windows had no significant effect on in-flight service quality (β = .056, t = 1.244, p > .05), rejecting H5. On the other hand, in-flight service quality positively affected traveler experience (β = .165, t = 3.685, p < .001), accepting H6.

To examine the mediation effect of in-flight service quality, Cheah et al.'s (2019) recommendation was employed to insert a confidence interval technique into bootstrapping results. This technique suggests that mediation is successful if zero does not lie between the lower and upper bounds. Accordingly, Table 4 findings discovered that intelligent seats positively affected traveler experience through in-flight service quality (β = .076, t = 2.448, p < .05, CI = .015-.137). This implied that in-flight service quality achieved partial mediation because all paths (i.e., direct and indirect) were significant and zero did not pass between the lower and upper bounds of this path, supporting H7a. Otherwise, smart overhead bins had no significant effect on traveler experience through in-flight service quality (β =.034, t = 1.346, p > .05, CI = -.015-.083). This confirmed that flight service quality achieved full mediation because direct paths were significant while indirect effects were insignificant, and zero passed between the lower and upper bounds of this path, supporting H7b.

Likewise, in-flight entertainment systems had no significant effect on traveler experience through in-flight service quality (β =.019, t = .684, p > .05, CI = -.044-.044). This proved that flight service quality achieved full mediation because direct paths were significant while indirect effects were insignificant, and zero passed between the lower and upper bounds of this path, supporting H7d. On the other hand, RFID for tracking luggage had no significant effect on traveler experience through in-flight service quality (β = .014, t = .443, p > .05, CI = -.049-.077). This showed that flight service quality did mediate this association because one of the direct paths and the indirect effect were insignificant, and zero passed between the lower and upper bounds of this path, rejecting H7c.

Similarly, smart dimmable windows had no significant effect on traveler experience through in-flight service quality (β = .009, t = .298, p > .05, CI = -.052-.070). This showed that flight service quality did mediate this association because one of the direct paths and the indirect effect were insignificant, and zero passed between the lower and upper bounds of this path, rejecting H7e.

4.4. Moderation effects

Airline endorsement was included as a grouping moderation variable for the relationship between in-flight service quality and traveler experience using a two-stage approach.

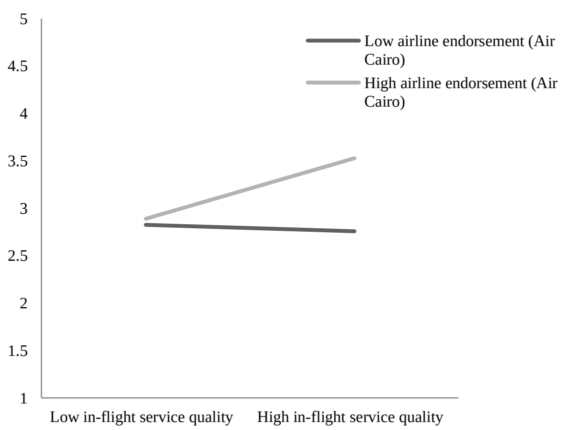
Table 5. Moderation analysis.

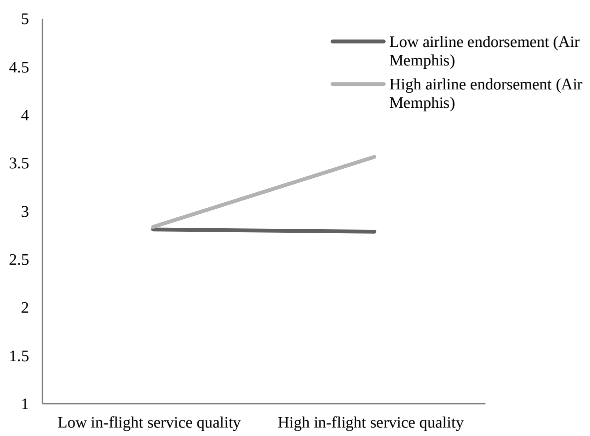
H	Path	Air Memphis (β)	Air Cairo (β)	FlyEgypt (β)	EgyptAir (β)	Alexandria Airlines (β)
Stage1	In-flight service quality → Traveler experience	.176**	.143**	.137*	.195**	.158**
Stage2	Airline endorsement → Traveler experience	.201**	.209**	.218**	.234**	.129**
H8	Airline endorsement*In-flight service quality → Traveler experience	.187**	.176**	.187**	.215**	.148**

Stage 1 proved that in-flight service quality positively affected traveler experience with $p < .01$ ($\beta_{Air\ Memphis} = .176$, $\beta_{Air\ Cairo} = .143$, $\beta_{FlyEgypt} = .137$, $\beta_{EgyptAir} = .195$, $\beta_{Alexandria\ Airlines} = .158$), as shown in Table 5. By comparing the differences between the five airline samples, it was discovered that in-flight service quality on Egypt Air aircraft significantly affected the experience of its travelers compared to other airlines.

Likewise, Stage 2 results proved that airline endorsement positively affected traveler experience with $p < .01$ ($\beta_{Air\ Memphis} = .201$, $\beta_{Air\ Cairo} = .209$, $\beta_{FlyEgypt} = .218$, $\beta_{EgyptAir} = .234$, $\beta_{Alexandria\ Airlines} = .129$), as shown in Table 5. By comparing the differences between the five airline samples, it was discovered that most participants support traveling on Egypt Air, which increases their enjoyable travel experiences. Accordingly, findings presented in Table 5 revealed that the moderation effect of the interaction term "airline endorsement*in-flight service quality" was significant and positively effected traveler experience ($\beta_{Air\ Memphis} = .187$, $\beta_{Air\ Cairo} = .176$, $\beta_{FlyEgypt} = .187$, $\beta_{EgyptAir} = .215$, $\beta_{Alexandria\ Airlines} = .148$) with $p < .01$. This supports H8, which indicates that airline endorsement strengthened the association between in-flight service quality and traveler experience.

By comparing the differences between the five samples, it was found that the more travelers supported Egypt Air, the greater the positive effect of the service quality expected to be obtained during air travel on their enjoyable experience characterized by smart technologies such as AR and Metaverse. To confirm the moderating effect, the high and low level slopes showed that all effects were strong and indicated the more travelers supported the airlines, the better their services provided on board their aircraft and thus will provide these travelers with an immersive and enjoyable experience, especially Egypt Air, which reached higher levels of support and endorsement than other airline firms (see Figure 2).





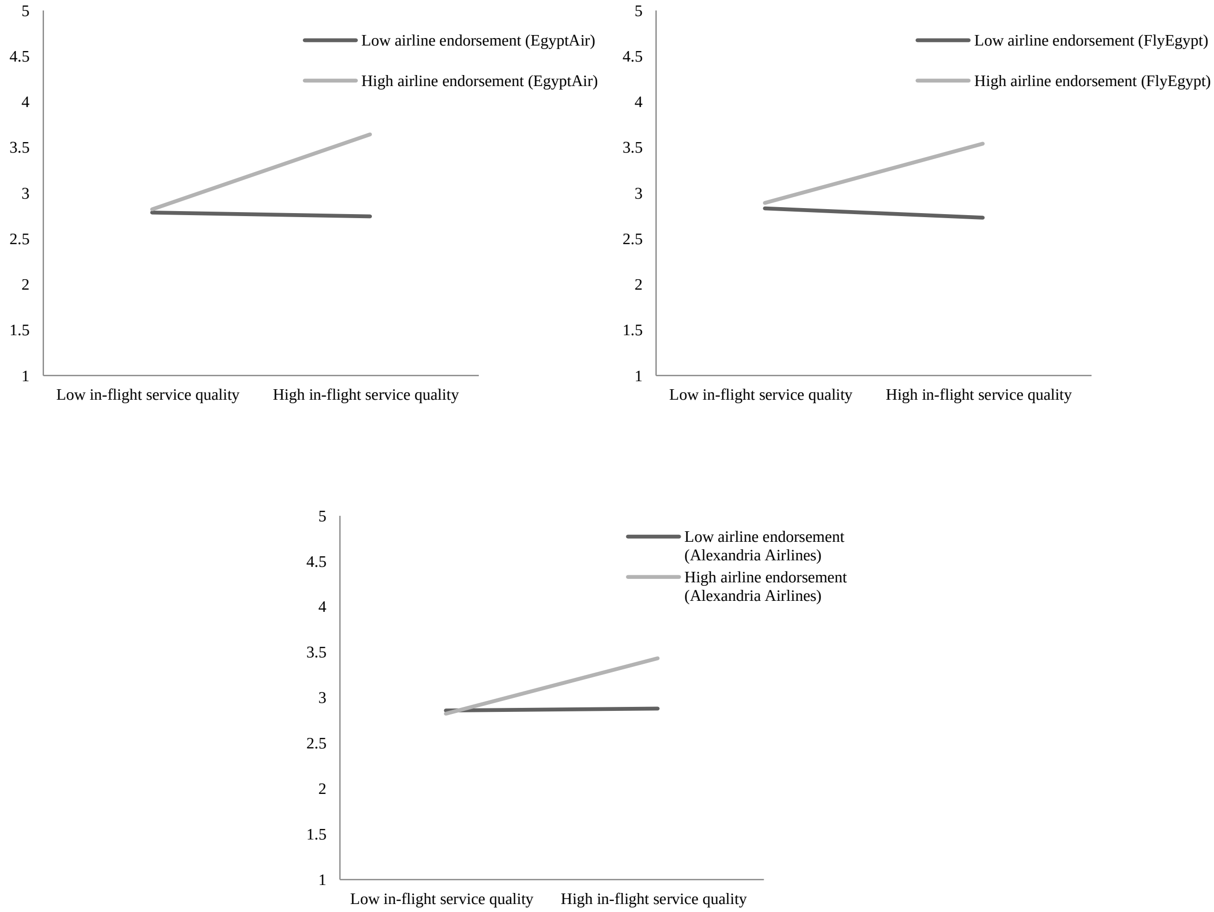


Figure 2. Interaction effect of airline endorsement.

5. Discussion and conclusion

Our paper highlighted the significance of smart technologies in enhancing in-flight service quality and traveler experience. Findings underscored the focal role of in-flight service quality as a mediator and the influence of airline endorsement as a moderator. These insights provide practical guidance for airlines seeking to improve passenger satisfaction and loyalty. While the study has its limitations, it opens doors for further research in the dynamic field of aviation and smart technology integration, with a focus on delivering exceptional travel experiences in the modern era of air travel.

Our findings align with and extend upon several key aspects of the theoretical framework and related studies, providing a comprehensive understanding of the impact of smart technologies on in-flight service quality and traveler experience. Our findings confirmed the positive impact of smart technologies on in-flight service quality, which resonates with Namukasa (2013). The integration of intelligent seats, smart overhead bins, and advanced in-flight entertainment systems significantly contributes to passengers' perceptions of security, comfort, and overall service quality (Rajapaksha & Jayasuriya, 2020). This consistency with prior research reinforces the importance of these amenities for modern air travel.

Furthermore, our findings aligned with De Crescenzio et al. (2021) underscore the enduring relevance of the factors influencing in-flight service quality. Smart amenities represent an evolution in the pursuit of enhanced service quality, building upon traditional elements such as cleanliness, employee grooming, and the quality of food service. In this digital age, passengers increasingly value the convenience and sophistication offered by smart technologies, which are reflected in their preferences for sensor-equipped seats, intelligent overhead bins, and cutting-edge entertainment systems.

Our study's exploration of mediation effect of in-flight service quality in the smart amenities-traveler experience relationship adds a valuable layer of understanding to existing literature. This mediation mechanism aligns with the concept that passengers' overall experience is shaped by their perceptions of service quality in-flights (Hoyer et al., 2020). The partial mediation observed in the case of intelligent seats and the full mediation for smart overhead bins and in-flight entertainment systems suggest that passengers not only value these smart amenities directly but also indirectly through their impact on service quality.

Passengers' satisfaction with intelligent seats enhances their perception of service quality, subsequently influencing their overall experience. Meanwhile, smart overhead bins and advanced entertainment systems primarily affect traveler experience indirectly, via their positive impact on service quality. This highlights the importance of airlines' investment in these smart amenities to elevate both service quality and passenger experience.

Our results indicate that passengers who endorse a particular airline have a more pronounced positive response to improvements in in-flight service quality. This aligns with Chih et al. (2020), which emphasizes the significance of brand perception and endorsement in shaping travelers' preferences. Passengers who strongly endorse an airline are more likely to perceive service quality enhancements as valuable and experience greater satisfaction during their journeys. This finding has practical implications for airlines seeking to cultivate customer loyalty and advocacy through investments in smart technologies and service quality improvements.

In summary, our research contributes to the existing theoretical framework by affirming the enduring importance of in-flight service quality in the context of modern air travel. We extend this framework by highlighting the moderating influence of airline endorsement. These insights provide airlines with actionable strategies to enhance traveler experiences and build stronger customer relationships in an increasingly competitive industry.

5.1. Practical implications

- Airline investment in smart technologies: Airlines, especially Egyptian Airlines, can benefit from investing in smart technologies such as intelligent seats, smart overhead bins, and advanced entertainment systems. These enhancements not only improve in-flight service quality but also contribute to a more enjoyable traveler experience, potentially leading to increased customer loyalty and positive word-of-mouth.
- Marketing and branding strategies: Airlines should consider leveraging positive endorsements and emphasizing their commitment to passenger satisfaction through smart amenities in marketing campaigns. Engaging with travelers on social media platforms can further strengthen their endorsement, enhancing the overall passenger experience.
- Customized services: Airlines can use passenger data and preferences to provide more personalized services through smart technologies. Tailored experiences can lead to higher levels of satisfaction and endorsement, fostering customer loyalty.

5.2. Limitations and future directions

This paper focused on Egyptian Airlines passengers with specific demographic characteristics (age and education level). This limits the generalizability of our findings to a broader population. Future research could incorporate objective measures or observations. Comparative studies across different cultures and regions could help identify cultural variations in passenger preferences and the impact of smart technologies on traveler experience. Future research can explore the integration of Metaverse and block chain in the airline industry and their effects on passenger experience. Investigating how airlines can use smart technologies to promote eco-friendly and sustainable travel practices while enhancing passenger satisfaction is an important avenue for future research.

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اسكتشاف التأثير المُحتمل للمرافق الذكية المقدُمة على متن الطائرة في تجربة المسافرين: الأدوار المحورية لجودة الخدمة وتأييد شركات الطيران

نرمين السيد محمد الحطاب
أستاذ مساعد بقسم الدراسات السياحية
المعهد العالي للسياحة والفنادق والحاسب الالي – سيوف – الاسكندرية

معلومات المقالة	الملخص

الكلمات المفتاحية
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قد تلعب جودة الخدمة المٌقدمة على متن الطائرات التابعة لشركات الطيران المصرية وتأييد المسافر لشركة طيران معينة دون عن غيرها أخرى أدواراً محوريةً في تبرير العلاقة المتأصلة بين المرافق الذكية وخلق تجربة غامرة للمسافرين عبر الخطوط الجوية. في هذا الصدد، تم الحصول على 487 مسافرًا محتملاً عبر الخطوط الجوية المصرية، سواء إلى خارج مصر أو قادمين إليها. كشفت نتائج Smart PLS 4 أن المقاعد الذكية، الحافظات العلوية الذكية ونظام الترفيه على متن الطائرة أثروا بشكل كبير في جودة الخدمات المُقدمة. إلى جانب ذلك، أثرت جودة الخدمة أثناء الرحلة السياحية بشكل إيجابي في تجربة المسافرين. علاوة على ذلك، فإن جودة الخدمة على متن الطائرة توسطت جزئيًا العلاقة بين توافر المقاعد الذكية وتجربة المسافرين، بينما توسطت كليًا العلاقة بين تجربة المسافرين وكل من الحافظات العلوية الذكية ونظام الترفيه على متن الطائرة. أخيرًا، عزز تأييد المسافرين لشركات الطيران العلاقة الإيجابية بين جودة الخدمة على متن الطائرة وتجربة المسافرين لصالح عينة شركة مصر للطيران. تسلط هذه الورقة الضوء على المساهمات الفعالة لصناع القرار في صناعة السياحة والسفر، فيما يتعلق بإمكانية تطوير الخطوط الجوية للمسافرين سواء لأغراض تجارية أو ترفيهية، فضلًا عن إمكانية تجهيز الطائرات بالتقنيات الناشئة كالنظارات الذكية المدعومة بإنترنت الأشياء وتطبيقات السفر المدعومة بتقنية الـ Metaverse.