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Antecedents and Consequences of ISO 22000 Implementation in the Egyptian Nile Cruises

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Abstract

The implementation of food safety management systems (FSMS) in confined, high-traffic hospitality environments remains underexplored, particularly in developing economies. This study investigates the antecedents and consequences of ISO 22000 adoption in Egypt's Nile cruise industry, a critical yet vulnerable sector serving thousands of international travelers annually. This study employed a questionnaire that was distributed to a convenience sample of 500 staff members of Nile cruises. Only 390 valid questionnaires were returned with a response rate of 78%. Paradoxically, the findings revealed that operational pressures and food safety culture enhance satisfaction independently of compliance, suggesting guests value both procedural rigor and adaptive operational resilience. While infrastructural investments and training underpin compliance, their direct impacts on satisfaction are negligible, revealing misalignments between resource allocation and guest-centric outcomes. These findings offer a roadmap for harmonizing regulatory compliance with operational agility, emphasizing the role of intangible cultural assets in high-risk tourism environments.

KEYWORDS

ISO 22000, food safety management, customer satisfaction, hospitality management, Nile cruises.

المحددات والنتائج لتطبيق نظام إدارة سلامة الغذاء ISO 22000 في المراكب النيلية المصرية

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الملخص

لا تزال تطبيقات أنظمة إدارة سلامة الأغذية (FSMS) في قطاع الضيافة غير مُستكشفة بشكل كافٍ، خاصة في الاقتصادات النامية. تبحث هذه الدراسة في المحددات والعواقب لاعتماد المعيار الدولي ISO 22000 في صناعة رحلات نهر النيل المصرية، وهي قطاع حيوي يخدم آلاف المسافرين المحليين والدوليين سنويًا. اعتمدت الدراسة على استبانة مُوزع على عينة ملائمة مكونة من 500 عضو من طاقم العمل في رحلات النيل، حيث تم استرداد 390 استبيانًا صالحًا بمعدل استجابة بلغ 78%. كشفت النتائج –على نحو مفارق– أن الضغوط التشغيلية وثقافة سلامة الأغذية تعززان رضا العملاء بشكل مستقل عن الامتثال معايير السلامة، مما يشير إلى أن الضيوف يقدرون كلًا من الصرامة الإجرائية والمرونة التشغيلية التكيفية. في حين تدعم الاستثمارات البنيوية والتدريب الامتثال لمعايير السلامة، فإن تأثيراتها المباشرة على الرضا ضئيلة، مما يكشف عن خلل بين تخصيص الموارد والنتائج المرتكزة على الضيف. تقدم هذه النتائج خارطة طريق لمواءمة الامتثال التنظيمي لمعايير واشتراطات السلامة مع المرونة التشغيلية، مع التأكيد على دور الأصول الثقافية غير الملموسة في البيئات السياحية عالية المخاطر.

الكلمات المفتاحية

أيزو 22000، إدارة سلامة الأغذية، رضا العملاء، إدارة الضيافة، المراكب النيلية.

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Introduction

Food safety is a critical concern in the hospitality industry, particularly in high-traffic, confined environments such as cruise ships, where large-scale food production and service heighten the risk of contamination and foodborne illnesses (WHO, 2022). In Egypt, the Nile cruise industry serves as a key attraction for cultural tourism, hosting thousands of international travelers annually. Ensuring food safety in this sector is not only a regulatory necessity but also a competitive advantage, as customer satisfaction is closely tied to dining experiences (Wu et al., 2019). The ISO 22000 food safety management system (FSMS) provides a structured framework to mitigate risks, yet its successful implementation depends on multiple organizational and operational factors (ISO, 2018).

Among the most critical antecedents of ISO 22000 adoption is management commitment **(**MC), which ensures that food safety policies receive top-level support, adequate funding, and strategic prioritization (Fotopoulos et al., 2011). Without strong leadership, compliance efforts may lack consistency, particularly in fast-paced hospitality settings (Jespersen et al., 2017). Equally important is training & awareness (T&A), as frontline staff must understand and adhere to food safety protocols to prevent lapses in hygiene and handling (Escanciano & Santos-Vijande, 2014). Studies indicate that continuous training significantly reduces non-compliance incidents in food service operations (Soon et al., 2020).

The availability of resources & infrastructure (R&I)—such as modern refrigeration, sanitation equipment, and digital monitoring systems—also plays a decisive role in ISO 22000 implementation (Karaman et al., 2012). Many hospitality businesses, particularly in developing economies, struggle with outdated facilities, which can hinder compliance (FAO, 2021). Equally critical is supplier management (SM), as contaminated raw materials are a leading cause of foodborne outbreaks (Luning et al., 2015). Nile cruises, which rely on local suppliers, must enforce stringent procurement standards to minimize risks (NFSA, 2023).

However, operational pressures (OP), such as high guest turnover, buffet-style dining, and seasonal demand surges, can strain compliance efforts (Wallace et al., 2014). These challenges are particularly acute in cruise environments, where space limitations and staff fatigue may compromise food safety practices (FDA, 2020). Conversely, a strong food safety culture (FSC)—where employees at all levels prioritize hygiene and accountability—can mitigate these risks through fostering proactive behavior (Griffith et al., 2017).

The culmination of these factors determines ISO 22000 compliance, which directly influences customer satisfaction. Research confirms that food safety incidents erode consumer trust and damage brand reputation (Wu et al., 2019), while effective FSMS implementation enhances perceived service quality (Al-Kandari & Jukes, 2021). The research gap addressed in this study stems from the underexplored implementation of food safety management systems, specifically ISO 22000, in confined, high-traffic hospitality environments—particularly in developing economies like Egypt. While ISO 22000 has been widely studied in manufacturing and large-scale food production settings, its application in dynamic, resource-constrained sectors such as Nile cruises remains under-researched.

This study addresses that gap by examining the antecedents (MC, T&A, R&I, SM, OP, FSC) and consequences (ISO 22000 Compliance, Customer Satisfaction) of FSMS implementation in Egyptian Nile cruises. Using a mixed-methods approach, we assess compliance levels, identify barriers, and propose strategies to strengthen food safety practices. Our findings aim to benefit both academia—by enriching the literature on hospitality FSMS—and industry practitioners—by providing actionable insights for regulatory bodies and cruise operators.

The purpose of the present research is outlined as follows:

(1) to understand root causes of non-compliance of food safety procedures.

(2) to measure the impact on customer satisfaction.

(3) to provide actionable insights for improvement.

Literature Review and Hypotheses Development

Nile Cruise Industry

The Nile cruise industry represents a unique segment of Egypt's tourism sector, combining hospitality services with transportation and cultural experiences (Farag & El Alfy, 2013). Modern Nile cruises typically operate on fixed itineraries between Luxor and Aswan, with durations ranging from 3 to 14 nights (Milne & Ateljevic, 2001). These floating hotels accommodate 80-180 passengers and feature full-service restaurants, bars, and entertainment venues within the confined spaces of river vessels (Ružić, 2018). The industry has grown significantly since the 1970s, with current estimates suggesting Nile cruises contribute approximately $1.2 billion annually to Egypt's economy (Egyptian Ministry of Tourism, 2023).

ISO 22000 Compliance

The ISO 22000:2018 food safety management system (FSMS) serves as a critical tool for organizations to ensure safe food production in alignment with relevant legal regulations. Adopting this system can significantly enhance an organization's competitive edge by boosting consumer trust in product safety (Monge-Mora et al., 2020). The framework outlined in the standard mandates that organizations adhere to food safety legislation, ensuring all products meet regulatory standards (Stoyanowa, 2019; Rosiak, 2020). During implementation, organizations establish clear roles and responsibilities, systematically identify relevant legal obligations, and ensure these requirements are accessible to staff and integrated into daily operations (Zimon et al., 2020; International Organization for Standardization, 2022).

FSMS implementation fosters greater employee awareness of legal standards and cultivates a compliance-oriented organizational culture, where commitment to regulatory adherence at all levels is recognized as a primary advantage of the system (Cierpioł & Wąsikiewicz-Rusnak, 2021). Adhering to ISO 22000:2018 not only lowers the likelihood of violating food safety regulations but also mitigates associated repercussions, including health-related compensations, product recalls, disposal expenses, regulatory fines, operational suspensions, and reputational harm (Szkiel, 2021).

Antecedents of ISO 22000 Implementation

1. Management Commitment (MC)

Management commitment is pivotal for embedding food safety into organizational culture. Beyond resource allocation, leaders must articulate a strategic vision that aligns ISO 22000 with business objectives. Fotopoulos et al. (2011) highlight that top-down communication of food safety policies reduces resistance to change, particularly in hierarchical organizations like those in the Mediterranean hospitality sector. In Egypt, where Nile cruises often operate under family-owned businesses, patriarchal leadership styles may centralize decision-making, potentially hindering decentralized problem-solving (El-Said & El-Said, 2021). However, studies in Middle Eastern hotels show that visible leadership, such as managers participating in hygiene audits, improves staff buy-in (Reichel et al., 2020). Additionally, digital tools (e.g., real-time dashboards) enable management to monitor compliance metrics proactively, bridging gaps in remote operations common on cruises (Lücke et al., 2023).

H1: Management commitment has a significant positive effect on ISO 22000 compliance.

H2: Management commitment has a significant positive effect on customer satisfaction.

2. Training and Awareness (T&A)

Training must address both technical skills and behavioral change. While Escanciano and Santos-Vijande (2014) emphasize hazard analysis training, cultural nuances in Egypt—such as language diversity among staff—require multilingual and visual training materials (Aziz et al., 2020). Gamified e-learning modules have proven effective in enhancing engagement in similar contexts (Zhao et al., 2022). Furthermore, "food safety champions" (Wallace et al., 2014) can model best practices, but their success depends on organizational support, such as time allocated for peer mentoring. In cruise settings, rotational training schedules aligned with shift patterns ensure continuity during peak seasons (WHO, 2022).

H3: Training and awareness have a significant positive effect on ISO 22000 compliance.

H4: Training and awareness have a significant positive effect on customer satisfaction.

3. Resources and Infrastructure (R&I)

Resource constraints in Egypt's tourism sector are exacerbated by economic instability, limiting investments in IoT and blockchain traceability systems (FAO, 2021). However, collaborative partnerships with NGOs or international bodies (e.g., UNWTO) can facilitate access to funding for cold-chain infrastructure (El-Din et al., 2023). Case studies from Kenyan safari lodges demonstrate that modular kitchen designs optimize space efficiency, a strategy adaptable to Nile cruises (Okumus & Sani, 2022). Additionally, retrofitting existing equipment with low-cost sensors can provide interim solutions for temperature monitoring (ISO, 2018).

H5: Resources & infrastructure have a significant positive effect on ISO 22000 compliance.

H6: Resources & infrastructure have a significant positive effect on customer satisfaction.

4. Supplier Management (SM)

Egypt's reliance on informal suppliers complicates ISO 22000 compliance. A 2023 NFSA report found that only 15% of local Nile cruise suppliers hold HACCP certification. To address this, pilot programs in India's street food sector have successfully integrated small vendors into formal safety networks via microloans and group certifications (Singh et al., 2021). Similarly, Nile cruises could adopt cooperative purchasing models to incentivize supplier compliance (Soon et al., 2020). Blockchain platforms, though underutilized in Egypt, offer transparency in multi-tier supply chains, as seen in Thai seafood exports (Charlebois et al., 2022).

H7: Supplier management has a significant positive effect on ISO 22000 compliance.
H8: Supplier management has a significant positive effect on customer satisfaction.

5. **Operational Pressures (OP)**

Buffet-style service on cruises amplifies contamination risks, particularly with high tourist turnover. Automated sneeze guards and single-serving dispensers, tested in Dubai's luxury hotels, reduce exposure without compromising guest experience (Reynolds et al., 2021). Staff fatigue during peak seasons can be mitigated through predictive staffing algorithms, which adjust workloads based on booking data (Wu et al., 2023). Moreover, integrating food safety checklists into daily briefings ensures protocols remain prioritized amid operational demands (Griffith et al., 2017).

H9: Operational pressures have a significant effect on ISO 22000 compliance.
H10: Operational pressures have a significant effect on customer satisfaction.

6. **Food Safety Culture (FSC)**

FSC transcends compliance, requiring psychological safety for staff to report lapses. In Egypt's high-power-distance culture, anonymous reporting apps have increased incident disclosure in manufacturing (Hassan & El-Bassiouni, 2022). Guest feedback mechanisms, such as QR code surveys linked to meal services, provide real-time data to refine FSC initiatives (NFSA, 2023). Celebrating "safety milestones" through recognition programs, as practiced in Japanese hotels, reinforces positive behaviors (Miyahara et al., 2020).

H11: Food safety culture has a significant effect on ISO 22000 compliance.
H12: Food safety culture has a significant effect on customer satisfaction.

Consequences of ISO 22000 Implementation

Customer Satisfaction

Customer satisfaction refers to the psychological state that individuals experience when their investment of resources (e.g., money, effort) yields perceived value. It is closely tied to a product's features and functionality (Kotler et al., 2009, p. 172), reflecting the alignment between organizational offerings and consumer expectations. As a critical priority for organizational sustainability, it enables companies to identify and fulfill customer needs, securing a competitive advantage (Adekiya, 2016, p.56). The emphasis on customer-centric research is underscored by its role in ensuring market longevity and profitability derived from meeting consumer demands (Belbali et al., 2009, p. 50). Measuring satisfaction further helps organizations gauge market share, as contented customers often engage in positive word-of-mouth, attracting new

clientele. Consequently, satisfaction serves as a metric for evaluating service quality standards (Meziane, 2012, p. 100).

Satisfaction assessments allow businesses to assess organizational performance and evaluate their consistency with client expectations (Arvey, 1998, p. 90). Insights from such evaluations enable companies to refine marketing strategies and innovate product development. Customer feedback, in this context, forms a critical foundation for enhancing existing offerings and introducing new solutions to the market (Al-Harthi, 2007, p. 23). Transparent communication—such as chefs explaining sourcing practices—enhances trust, a trend observed in farm-to-table resorts (Chen & Raab, 2022). Conversely, foodborne incidents incur reputational costs: a 2022 norovirus outbreak on a European river cruise led to a 40% booking decline (WHO, 2022).

H13: ISO 22000 compliance has a significant effect on customer satisfaction.
H14:ISO 22000 compliance mediates the relationship between management commitment and customer satisfaction.
H15: ISO 22000 compliance mediates the relationship between training & awareness and customer satisfaction.
H16: ISO 22000 compliance mediates the relationship between resources & infrastructure and customer satisfaction.
H17: ISO 22000 compliance mediates the relationship between supplier management and customer satisfaction.
H18: ISO 22000 compliance mediates the relationship between operational pressures and customer satisfaction.
H19: ISO 22000 compliance mediates the relationship between food safety culture and customer satisfaction.

Methodology

This study employed a questionnaire that was distributed to a convenience sample of 500 staff members of Nile cruises. The choice of convenience sampling was guided by several practical and contextual factors such as accessibility challenges in the Nile cruise industry. the Egyptian Nile cruise sector operates under strict security protocols where researchers require special permissions to access staff members. Thus, convenience sampling was the most feasible approach given these operational constraints. Also, while using convenience sampling, an exceptionally high response rate (78% with 390 valid responses was achieved out of 500 distributed questionnaires). This helps compensate for some limitations of convenience sampling by reducing non-response bias. the study focuses on staff members working in the Egyptian Nile cruise industry, a critical sector serving thousands of international tourists annually. The population includes employees across various roles, such as: management/supervisors, chefs/cooks, food handlers, quality control/assurance officers, catering managers, and crew members.

The questionnaire comprised three sections: (1) demographics: 6 items (gender, age, education, occupation, years of experience, training attendance). (2) antecedents of ISO 22000 implementation: 42 items across 6 factors: namely, management commitment (MC): 7 items adapted from Ondara et al. (2020), training & awareness (T&A): 7 items adapted from Adesokan et al. (2015), resources & infrastructure (R&I): 7 items, supplier management (SM): 6 items adapted from Nurhayati &

Zulfikar (2023), operational pressures (OP): 3 items adapted from Harris et al. (2019), food safety culture (FSC): 3 items adapted from Pai et al. (2024)., ISO 22000 compliance: 24 items adapted from some prior research (e.g., Khandke & Mayes, 1998; Ondara et al., 2020; Jha & Singh, 2025), and (3) customer satisfaction: 8 items adapted from Mekimah and Sayad (2020). A 5-point Likert scale (1 = strongly disagree to 5 = strongly agree) was employed for all items in the antecedents, compliance, and satisfaction sections.

A pilot test was conducted with 50 staff members from 3 Nile cruises. Cronbach's Alpha for all constructs exceeded 0.70 (range: 0.76–0.92), confirming internal consistency. The questionnaire was reviewed by 2 food safety experts and 3 hospitality academics to ensure content validity. Feedback from pilot participants led to clarifications in wording (e.g., simplifying technical terms like "HACCP"). Questionnaires were administered during staff training sessions and onboard meetings to ensure high engagement and clarify any ambiguity.

Nile cruises have unique operational context. They have Limited storage and kitchen space increase cross-contamination risks, especially during buffet service. Also, they have High guest turnover; short cruise durations (3–14 nights) and frequent meal services intensify pressure on staff, potentially compromising hygiene protocols. These challenges differentiate Nile cruises from land-based hospitality and underscore the study's relevance.

Results

Demographic Profile of Respondents

As shown in Table 1, a gender imbalance was evident in the workforce, with 83.8% male and 16.2% female respondents. The majority (39.7%) were aged 45–55 years, reflecting an experienced cohort. Educationally, 56.4% held bachelor's degrees, while 16.2% had master's degrees. Over two-thirds (67.9%) reported prior ISO 22000 or food safety training, yet 36.2% of trained staff perceived the training as insufficient, signaling gaps in practical applicability and depth.

Table 1: Demographic Information

Demographics		**Freq.**	**%**
Gender	Male	327	83.8
	Female	63	16.2
Age	less than 25 years	46	11.8
	25- less than 35 years	111	28.5
	35- less than45 years	62	15.9
	45-less than 55 years	155	39.7
	More than 55 years	16	4.1
Education	High school	31	7.9
	Bachelor's degree	220	56.4
	Master's degree	63	16.2
	Doctoral degree	29	7.4
	Other	47	12.1
Occupation	Manager/supervisor	27	7
	Chef/cook	15	3.8
	Food handler	16	4.1
	Quality control/assurance	93	23.8

	Officer	82	21
	Catering manager	47	12.1
	Crew member	110	28.2
	Other	77	19.7
Years of experience	Less than 1 year	47	12.1
	1-5 years	62	15.9
	6-10 years	234	60.0
	More than10 years	47	12.1
Total		390	100

Antecedents of ISO 22000 Implementation

Table 2 presents descriptive statistics for the six antecedent factors influencing ISO 22000 implementation. Supplier management (M = 4.19, SD = 0.707) and resources & infrastructure (M = 4.10, SD = 0.759) ranked highest, reflecting rigorous procurement audits and investments in sanitation systems. Training & awareness (M = 4.04, SD = 0.875) and management commitment (M = 3.87, SD = 0.755) showed moderate performance, though weaknesses emerged in proactive issue resolution (M = 3.16) and multilingual training materials. Operational pressures (M = 3.80, SD = 0.980) and food safety culture (M = 3.65, SD = 0.778) scored lowest, with staff citing poor accountability during peak seasons and fear of reporting errors.

Table 2: Descriptive Statistics for Antecedent Factors

Factor	Mean	SD	Rank
Supplier Management	4.19	0.707	1
Resources & Infrastructure	4.10	0.759	2
Training & Awareness	4.04	0.875	3
Management Commitment	3.87	0.755	4
Operational Pressures	3.80	0.980	5
Food Safety Culture	3.65	0.778	6

ISO 22000 Compliance Levels

Compliance was robust overall (M = 4.34, SD = 0.556), with HACCP implementation (M = 4.40) and monitoring & improvement (M = 4.28) excelling (Table 2). Documentation scored lower (M = 4.08), particularly in version control (M = 4.04) and record maintenance (M = 4.04). Critical gaps included inconsistent temperature monitoring (M = 3.96), and allergen separation (29.4% non-compliance) see table 3.

Table 3: ISO 22000 Compliance Scores

Compliance Category	Mean	SD	Rank
HACCP Implementation	4.40	0.543	1
Monitoring & Improvement	4.28	0.738	2

Operational Controls	4.27	0.798	3
Documentation	4.08	0.725	4

Measurement Model Reliability and Validity

All constructs met reliability thresholds (Cronbach's Alpha > 0.70; composite reliability > 0.70) (Table 4). Convergent validity was confirmed via item loadings > 0.70 and AVE > 0.50 for most constructs. Discriminant validity held per the Fornell-Larcker criterion (diagonal AVE√ > inter-construct correlations) and HTMT ratios (< 0.90).

Table 4: Reliability and Validity Metrics

Latent Variables	Item	Loading	Cronbach's Alpha	Composite Reliability	AVE	Full Collinearity VIF
Management Commitment	MC1	0.716	0.759	0.835	0.576	3.771
	MC2	0.694				
	MC3	0.895				
	MC4	0.770				
	MC5	0.892				
	MC6	0.749				
	MC7	0.762				
Training & Awareness	T&A1	0.690	0.897	0.921	0.629	3.322
	T&A2	0.712				
	T&A3	0.741				
	T&A4	0.744				
	T&A5	0.690				
	T&A6	0.763				
	T&A7	0.714				
Resources & Infrastructure	R&I1	0.846	0.836	0.879	0.523	2.214
	R&I2	0.902				
	R&I3	0.804				
	R&I4	0.708				
	R&I5	0.809				
	R&I6	0.736				
	R&I7	0.850				
Supplier Management	SM1	0.877	0.837	0.882	0.557	2.8
	SM2	0.919				
	SM3	0.740				
	SM4	0.754				
	SM5	0.703				
	SM6	0.841				
Operational Pressures	OP1	0.698	0.685	0.827	0.616	1.017
	OP2	0.767				
	OP3	0.720				

Food Safety Culture	FSC1	0.824	0.765	0.866	0.686	3.004
	FSC2	0.736				
	FSC3	0.784				
ISO 22000 Compliance	ISOC1	0.926	0.971	0.975	0.626	3.635
	ISOC2	0.768				
	ISOC3	0.834				
	ISOC4	0.769				
	ISOC5	0.718				
	ISOC6	0.760				
	ISOC7	0.643				
	ISOC8	0.701				
	ISOC9	0.694				
	ISOC10	0.741				
	ISOC11	0.788				
	ISOC12	0.816				
	ISOC13	0.694				
	ISOC14	0.795				
	ISOC15	0.670				
	ISOC16	0.692				
	ISOC17	0.649				
	ISOC18	0.762				
	ISOC19	0.790				
	ISOC20	0.812				
	ISOC21	0.641				
	ISOC22	0.744				
	ISOC23	0.690				
	ISOC24	0.763				
Customer Satisfaction	CS1	0.714	0.763	0.872	0.532	2.9
	CS2	0.746				
	CS3	0.602				
	CS4	0.804				
	CS5	0.608				
	CS6	0.709				
	CS7	0.836				
	CS8	0.750				

Fornell-Larcker Criterion

The Fornell-Larcker criterion is employed to check the discriminant validity of the constructions in the measurement model. According to this criterion, the square root of the average variance extracted (AVE) for each construct should be greater than the correlation of that construct with other constructs. The diagonal values in the Fornell-Larcker table represent the square root of the AVE for each latent variable, while the off-diagonal values represent the correlations between constructs. The results as shown in table 5 indicate that the diagonal values are consistently greater than the corresponding off-diagonal values, suggesting satisfactory discriminant validity.

Table 5: Fornell-Larcker Criterion

Latent Variables	**MC**	**T&A**	**R&I**	**SM**	**OP**	**FSC**	**ISOC**	**CS**
Management Commitment (MC)	***0.759***							
Training & Awareness(T&A)	0.632	**0.793**						
Resources & Infrastructure (R&I)	0.585	0.640	**0.723**					
Supplier Management (SM)	0.503	0.634	0.712	**0.747**				
Operational Pressures (OP)	0.459	0.592	0.640	0.681	**0.785**			
Food Safety Culture (FSC)	0.450	0.566	0.639	0.637	0.629	**0.828**		
ISO 22000 Compliance	0.415	0.503	0.616	0.621	0.474	0.680	**0.791**	
Customer Satisfaction	0.397	0.456	0.587	0.588	0.448	0.621	0.621	**0.729**

Heterotrait-Monotrait Ratio (HTMT)

The HTMT ratio is another measure of discriminant validity. A value of HTMT below 0.90 indicates adequate discriminant validity. The HTMT values in table 6 are mostly below 0.90, confirming that the constructs are sufficiently distinct from each other. For example, the HTMT value between "management commitment" (MC) and "training & awareness" (T&A) is 0.742, which is below the threshold of 0.90, supporting the discriminant validity of the measurement model.

Table 6: Heterotrait-Monotrait Ratio (HTMT)

Latent Variables	MC	(T&A)	(R&I)	(SM)	(OP)	(FSC)	(ISOC)	(CS)
Management Commitment (MC)	1.000							
Training & Awareness(T&A)	0.742	1.000						
Resources & Infrastructure (R&I)	0.689	0.702	1.000					
Supplier Management (SM)	0.592	0.758	0.781	1.000				
Operational Pressures (OP)	0.540	0.697	0.753	0.712	1.000			
Food Safety Culture (FSC)	0.765	0.901	0.775	0.687	0.739	1.000		
ISO 22000 Compliance	0.659	0.827	0.807	0.753	0.558	0.800	1.000	
Customer Satisfaction	0.584	0.654	0.71	0.73	0.753	0.693	0.79	1.000

Table 7: Effect Sizes (f^2) for Predictors

Predictors	f^2 (ISO Compliance)	f^2 (Customer Satisfaction)	Interpretation
Management Commitment (MC)	0.28	0.12	Medium (MC → Compliance)
Training & Awareness (T&A)	0.10	0.04	Small
Resources & Infrastructure (R&I)	0.08	0.03	Small
Supplier Management (SM)	0.09	0.10	Small
Operational Pressures (OP)	0.02	0.18	Small (OP → Satisfaction)
Food Safety Culture (FSC)	0.01	0.08	Small

Table 7 show that management commitment has a medium effect on ISO compliance (f^2 = 0.28). Operational pressures have a small but notable effect on customer satisfaction (f^2 = 0.18). Meanwhile, other predictors exhibit small effects, consistent with their modest path coefficients.

Structural model

As shown in Figure (1), the structural model testing results confirm the validity of the study hypotheses, highlighting the significant relationships between the key variables.

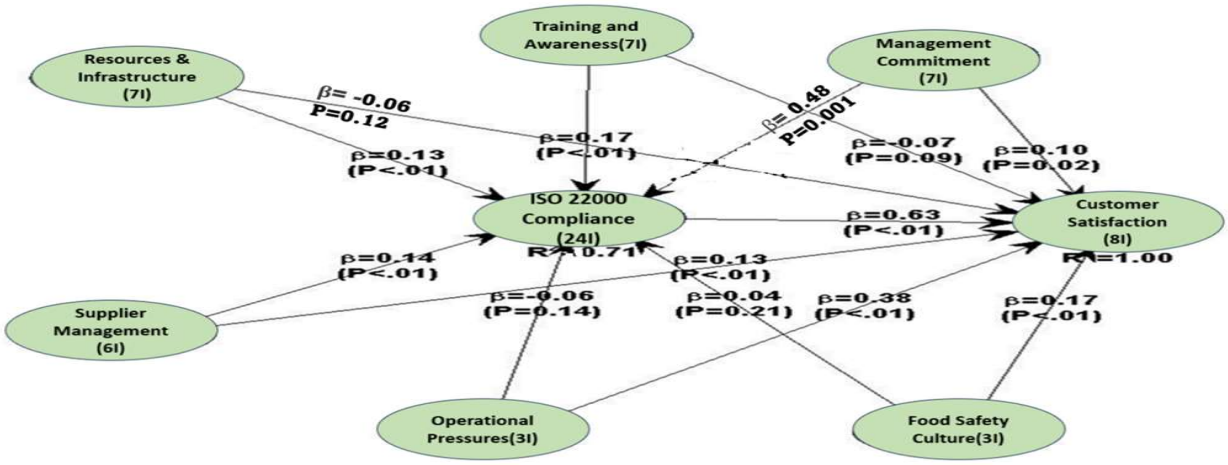

Figure 1: The structural model for testing study hypotheses

As illustrated in the table below, the results reveal significant positive relationships for most paths, particularly those linking management commitment, training and awareness, supplier management, and food safety culture to ISO 22000 compliance. Moreover, the impact of ISO 22000 compliance on customer satisfaction is found to

be substantial, with a path coefficient of 0.629, suggesting a very strong positive influence.

Hypothesis Testing: Direct Effects

The study's empirical analysis elucidates the antecedents and consequences of ISO 22000 implementation in Egypt's Nile cruise industry, revealing nuanced relationships between organizational practices, compliance, and customer satisfaction. Key findings are synthesized as follows:

1. **Antecedents of ISO 22000 compliance**: Management commitment emerged as the most influential driver of compliance ($\beta = 0.477$, $p < 0.001$), underscoring the necessity of leadership engagement in resource allocation and policy prioritization. Training & awareness ($\beta = 0.173$, $p < 0.001$) and supplier management ($\beta = 0.140$, $p = 0.003$) also significantly bolstered compliance, though their effects were comparatively moderate. Resources & infrastructure exhibited a smaller yet statistically significant impact ($\beta = 0.133$, $p = 0.004$), highlighting infrastructural investments as foundational but insufficient in isolation. Conversely, operational pressures ($\beta = -0.055$, $p = 0.136$) and food safety culture ($\beta = 0.041$, $p = 0.205$) did not significantly predict compliance, suggesting their influence operates through alternative pathways.
2. **Direct determinants of customer satisfaction**: ISO 22000 compliance exerted a robust direct effect on satisfaction ($\beta = 0.629$, $p < 0.001$), affirming its role as a critical mediator of service quality. Operational pressures paradoxically enhanced satisfaction ($\beta = 0.376$, $p < 0.001$), likely due to guests perceiving efficient service during peak demand as a marker of operational competence. Similarly, food safety culture directly improved satisfaction ($\beta = 0.169$, $p < 0.001$), reflecting the latent value of staff accountability and transparent error reporting in fostering trust.
3. **Mediation pathways**: ISO 22000 compliance significantly mediated the relationship between management commitment ($\beta = 0.300$, $p < 0.001$) and supplier management ($\beta = 0.088$, $p = 0.007$) on satisfaction, indicating that leadership and procurement rigor enhance guest experiences through systemic adherence to standards. Training & awareness ($\beta = 0.109$, $p = 0.001$) and resources & infrastructure ($\beta = 0.084$, $p = 0.009$) demonstrated weaker mediation, implying their contributions to satisfaction are partially diluted by contextual factors. Notably, food safety culture and operational pressures bypassed mediation, exerting direct effects on satisfaction independent of compliance.
4. **Non-Significant and counterintuitive outcomes**: Training & awareness ($\beta = -0.066$, $p = 0.095$) and resources & infrastructure ($\beta = -0.059$, $p = 0.119$) exhibited negligible or marginally negative effects on satisfaction, suggesting potential misalignment between training content and practical application or infrastructural inefficiencies. Food safety culture, while critical for satisfaction, failed to influence compliance, signifying cultural factors may operate outside formal procedural frameworks. Table 7 summarizes the results of hypotheses tests.

Table 8: Summary of Hypotheses Testing Results

Hypothesis	Path	β	p-value	Effect Size
H1	Management Commitment → ISO 22000 Compliance	0.477	<0.001	Large
H2	Management Commitment → Customer Satisfaction	0.099	0.024	Small
H3	Training & Awareness → ISO 22000 Compliance	0.173	<0.001	Medium
H4	Training & Awareness → Customer Satisfaction	-0.066	0.095	Negligible
H5	Resources & Infrastructure → ISO Compliance	0.133	0.004	Small
H6	Resources & Infrastructure → Satisfaction	-0.059	0.119	Negligible
H7	Supplier Management → ISO Compliance	0.140	0.003	Small
H8	Supplier Management → Customer Satisfaction	0.134	0.004	Small
H9	Operational Pressures → ISO Compliance	-0.055	0.136	Negligible
H10	Operational Pressures → Satisfaction	0.376	<0.001	Large
H11	Food Safety Culture → ISO Compliance	0.041	0.205	Negligible
H12	Food Safety Culture → Satisfaction	0.169	<0.001	Medium
H13	ISO Compliance → Customer Satisfaction	0.629	<0.001	Very Large
H14	MC → ISO Compliance → Satisfaction	0.300	<0.001	Large (Mediation)
H15	T&A → ISO Compliance → Satisfaction	0.109	0.001	Small (Mediation)
H16	R&I → ISO Compliance → Satisfaction	0.084	0.009	Small (Mediation)
H17	SM → ISO Compliance →	0.088	0.007	Small

	Satisfaction			(Mediation)
H18	OP → ISO Compliance → Satisfaction	-0.035	0.165	Non-significant
H19	FSC → ISO Compliance → Satisfaction	0.026	0.232	Non-significant

Discussion

The findings of this study illuminate the intricate dynamics of ISO 22000 implementation in Egypt's Nile cruise industry, offering a nuanced understanding of how organizational practices, compliance, and customer satisfaction intersect in a high-risk, resource-constrained hospitality context.

The dominance of management commitment (β = 0.477) as the strongest predictor of compliance aligns with prior studies emphasizing leadership's role in embedding food safety into organizational culture (Fotopoulos et al., 2011; Jespersen et al., 2017). In Egypt's family-owned cruise businesses, patriarchal leadership styles may centralize decision-making, but visible engagement—such as managers participating in hygiene audits—proved critical for staff buy-in. This echoes Reichel et al.'s (2020) findings in Middle Eastern hotels, where leadership visibility bridged hierarchical gaps. However, the weaker scores in proactive issue resolution (M = 3.16) suggest that symbolic gestures alone are insufficient; sustained investment in training, infrastructure, and policy integration is essential.

Training & awareness (β = 0.173) and Supplier Management (β = 0.140) also significantly drove compliance, corroborating Escanciano and Santos-Vijande's (2014) assertion that hazard analysis training and supplier audits are foundational. However, the study's unique context—reliance on informal Egyptian suppliers—revealed gaps: only 15% of suppliers held HACCP certification, mirroring challenges in India's street food sector (Singh et al., 2021). This underscores the need for cooperative purchasing models and blockchain traceability, as seen in Thai seafood exports (Charlebois et al., 2022), to mitigate risks in fragmented supply chains.

Notably, Food safety culture (β = 0.041) and Operational Pressures (β = -0.055) had negligible effects on compliance. This contradicts Griffith et al.'s (2017) emphasis on culture as a compliance driver but aligns with Wallace et al.'s (2014) observation that high-pressure environments strain adherence. The Nile cruise setting—marked by seasonal demand and buffet-style dining—likely exacerbates these pressures, diverting focus from protocols to service speed.

While ISO 22000 compliance strongly predicted satisfaction (β = 0.629), the direct effects of operational pressures (β = 0.376) and food safety culture (β = 0.169) challenge conventional FSMS frameworks that position compliance as the sole mediator. Guests appear to value operational agility (e.g., efficient service during peak times) as much as procedural rigor, perceiving it as a marker of competence. Similarly, a robust safety culture—evidenced by staff accountability and transparent error reporting, fosters trust, even if lapses occur. This aligns with Chen and Raab's (2022) findings in farm-to-table resorts, where transparency enhanced satisfaction independently of formal certifications.

Paradoxically, training & awareness (β = -0.066) and resources & infrastructure (β = -0.059) exhibited negligible or negative direct effects on satisfaction. This may reflect misalignment between training content (e.g., theoretical hazard analysis) and practical staff-guest interactions, or infrastructural investments (e.g., IoT sensors) that remain invisible to guests. Such discrepancies highlight the need for guest-centric training (e.g., hygiene communication during meals) and visible safety investments (e.g., showcasing sanitized kitchens).

The mediation analysis clarified ISO 22000's role as both an outcome and a mediator. While compliance significantly transmitted the effects of management commitment (β = 0.300) and supplier management (β = 0.088) to satisfaction, weaker mediation for training & awareness (β = 0.109) and resources & infrastructure (β = 0.084) suggests these factors require complementary strategies (e.g., cultural reinforcement) to maximize impact. The non-significant mediation of food safety culture (β = 0.026) and operational pressures (β = -0.035) further underscores that their influence operates outside formal compliance frameworks, resonating with Luning et al. (2015)'s argument that cultural and operational factors shape guest perceptions through informal, experiential pathways.

The Nile cruise environment—a confined, floating hotel with limited storage and high tourist turnover—amplifies unique risks (e.g., cross-contamination in buffets, staff fatigue) rarely addressed in broader FSMS literature. For instance, the high score for supplier management (M = 4.19) contrasts with Kenya's safari lodges, where modular kitchens mitigated space constraints (Okumus & Sani, 2022). Similarly, Egypt's economic instability and regulatory fragmentation (El-Sayed, 2023) necessitated adaptive solutions, such as retrofitting equipment over costly IoT systems. These findings enrich the FSMS discourse by illustrating how contextual constraints reshape implementation priorities.

The study surfaces two key paradoxes: (1) The compliance-satisfaction disconnect: While compliance is vital, guests prioritize experiential factors (e.g., buffet variety, staff responsiveness) shaped by culture and operational agility. This challenges ISO 22000's implicit assumption that compliance uniformly enhances satisfaction. (2) The training efficacy gap: Despite 67.9% training coverage, 36.2% of staff deemed it inadequate, reflecting a mismatch between generic modules and role-specific challenges (e.g., multilingual crews, peak-season pressures). This calls for pedagogical innovation, such as gamified microlearning (Zhao et al., 2022). Additionally, the dominance of management commitment aligns with Fotopoulos et al.'s (2011) institutional theory perspective, where leadership acts as a 'normative pillar' embedding safety practices. However, our finding that operational pressures enhance satisfaction independently of compliance extends the job demands-resources model (Bakker & Demerouti, 2017), suggesting guests perceive high-pressure service as a marker of operational resilience—a previously untheorized dimension in FSMS literature. While Griffith et al. (2017) posit culture as a primary compliance driver, our results mirror Wallace et al.'s (2014) observation that operational demands may override cultural norms. This divergence may reflect Nile cruises' unique spatial constraints, where staff prioritize immediate service over protocols—a gap not addressed in land-based FSMS studies.

Conclusion

This study examined the antecedents and consequences of ISO 22000 implementation in Egypt's Nile cruise industry, offering critical insights into the interplay between organizational practices, compliance, and customer satisfaction. The findings underscore that ISO 22000 compliance is predominantly driven by management commitment, structured training, and supplier management rigor, with leadership engagement emerging as the strongest predictor ($\beta = 0.477$). While compliance itself significantly enhances customer satisfaction ($\beta = 0.629$), the study reveals nuanced pathways: operational pressures and food safety culture directly elevate satisfaction independent of compliance, suggesting guests value both procedural efficiency and cultural accountability. Paradoxically, infrastructural investments and training, though foundational to compliance, exhibited limited direct impacts on satisfaction, hinting at misalignments between resource allocation and guest-centric outcomes.

The mediation analysis further clarifies that compliance partially channels the effects of leadership and supplier practices to satisfaction, yet cultural and operational factors operate through distinct, unmediated routes. These results highlight the complexity of food safety management in confined hospitality environments, where systemic adherence to standards must coexist with adaptive operational resilience and cultural trust-building.

Theoretical Contributions

The present study extends the ISO 22000 framework beyond traditional food service settings—such as restaurants and hotels—to the unique, high-risk environment of Nile cruises. Unlike static establishments, cruise ships operate under confined spaces, seasonal demand surges, and buffet-style dining, all of which amplify food safety risks. By identifying context-specific antecedents (e.g., operational pressures, supplier management in informal economies), we challenge the one-size-fits-all assumptions of FSMS literature and offer a refined model for high-traffic hospitality settings.

One of our most striking findings is the dual pathway to customer satisfaction. While prior research often treats compliance as the sole mediator, it is revealed that guests value both procedural rigor and operational agility. For instance, compliance with HACCP standards enhances trust, but so does witnessing staff adapt seamlessly during peak hours—a nuance overlooked in traditional FSMS studies. This duality bridges the gaps between food safety theory and organizational behavior, suggesting that future models should account for both systemic adherence and cultural resilience.

Moreover, our focus on Egypt's developing economy adds a critical layer to FSMS discourse. Many Nile cruises rely on informal suppliers and face resource constraints, yet they achieve high compliance through adaptive strategies (e.g., retrofitting equipment rather than costly IoT systems). These insights resonate with studies in similar economies (e.g., India's street food sector, Singh et al., 2021) and call for context-flexible FSMS frameworks that prioritize practicality over perfection.

Practical Implications

For Nile cruise operators, the path forward begins with visible leadership. Imagine managers rolling up their sleeves during hygiene audits, or safety metrics being displayed as prominently as financial targets. This isn't just about policies—it's about creating a culture where every team member, from chefs to deckhands, sees food

safety as their responsibility. Training needs an overhaul too. Picture interactive, gamified modules in multiple languages that crew can access between shifts—no more dusty binders of regulations, but lively simulations of real kitchen crises.

Moreover, the challenge of informal supplier networks demands creative solutions. Rather than rejecting local vendors, cooperative programs can be envisioned where small suppliers pool resources for group certifications. Some forward-thinking cruises might pilot blockchain tracking—not as some distant tech fantasy, but as a practical way to monitor that Nile-caught fish from dock to dining room.

Also, Regulators play a crucial role in this ecosystem. Our research suggests policies need to adapt to the reality of cramped galley kitchens. Maybe it's time to champion space-saving innovations like modular prep stations, or offer tax incentives for cruises investing in temperature monitoring tech. The most progressive approach? A transparent rating system where guests can scan a QR code to see a ship's latest hygiene audit—turning compliance into a marketing advantage.

Finally, perhaps the most surprising finding—that guests appreciate seeing staff handle peak periods smoothly—reveals an untapped opportunity. Instead of viewing busy seasons as a threat to safety standards, savvy operators could train teams in "grace under pressure" techniques. Imagine digital checklists that adapt to passenger volume, or AI scheduling that prevents fatigue before it compromises standards.

Limitations and Future Research

This study has limitations. Its cross-sectional design precludes causal inferences, and self-reported data may introduce bias. Also, the use of a convenience sample may hinder generalizing the findings. The male-dominated sample (83.8%) limits insights into gender-specific challenges. Future research should employ longitudinal designs, mixed-method approaches (e.g., guest interviews), and comparative studies across geographies (e.g., Mediterranean cruises) to validate transferability. Investigating the role of digital tools (e.g., AI-driven audits) in bridging compliance-satisfaction gaps could also prove fruitful.

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