

## E-business platforms for animation services in hospitality: Sustainable revenue models and digital transformation impact in European hotels (2022-2024)

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### Article history:

Received: April 07, 2025

1st Revision: October 02, 2025

Accepted: November 11, 2025

### JEL classification:

L83

L86

Q56

M21

### DOI:

[10.14254/jems.2025.10-2.4](https://doi.org/10.14254/jems.2025.10-2.4)

**Abstract:** *Purpose.* This study investigates the impact of e-business platforms for animation services on environmental sustainability metrics and revenue performance in the European hospitality sector. It aims to determine how digital transformation in entertainment services contributes to the Sustainable Development Goals while simultaneously optimizing hotel profitability. *Methodology.* A mixed-methods comparative analysis was conducted on a sample of 147 hotels (3–5 stars) across eight EU countries (2022–2024). The study compared 74 properties utilizing digital booking platforms for animation services against 73 using traditional methods. Data sources included Booking.com analytics, corporate sustainability reports, and Eurostat tourism data. The analysis employed multiple linear regression, independent-samples t-tests, and Pearson correlation to assess the relationships between digital adoption, environmental metrics, and financial outcomes. *Results.* Hotels adopting digital animation platforms demonstrated a 43.9% reduction in paper consumption, a 10.1% increase in energy efficiency, and a 25.4% improvement in waste reduction compared to traditional operators. Financially, these properties achieved a 26.5% increase in animation service revenue per room night. Mobile-friendly

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interfaces and real-time availability were identified as critical drivers of guest adoption and satisfaction. *Theoretical contribution.* The research provides the first systematic empirical evidence linking the digitalization of animation services to measurable sustainability outcomes, extending the Technology Acceptance Model to experiential hospitality services. It validates the integration of environmental impact measurement with financial performance analysis in the context of hotel entertainment. *Practical implications.* The findings offer hotel managers a validated framework for digital investment, indicating a 4.0-year payback period. The results support decision-making for digital transformation strategies that align operational efficiency with EU Green Deal objectives and corporate sustainability targets.

**Keywords:** e-business platforms, hospitality sustainability, digital transformation, animation services, revenue optimization, European hotels, sustainable tourism

**Sustainable Development Goals (SDGs):** **SDG 8:** Decent Work and Economic Growth; **SDG 9:** Industry, Innovation and Infrastructure; **SDG 12:** Responsible Consumption and Production

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## 1. Introduction

In this study, ‘animation services’ refer to hotel entertainment programs, recreational activities, and guest engagement initiatives, following the European hospitality terminology, rather than film animation.

The European hospitality industry is at the forefront of an unprecedented digital transformation, with online hotel revenues growing from €156.8 billion in 2019 to €268.4 billion in 2023, a 71.1% increase over four years (D-EDGE, 2024). This digital revolution has fundamentally reshaped traditional business models, compelling hotel operators to reconceptualize guest service delivery mechanisms, particularly for recreational and entertainment offerings previously categorized as animation services.

Animation services, encompassing recreational activities, entertainment programs, cultural events, and wellness experiences, have historically operated through conventional offline booking systems, paper-based reservations, and manual coordination processes. However, the convergence of post-pandemic digital acceleration and evolving guest expectations has necessitated a paradigm shift toward integrating e-business platforms for these ancillary services (Deloitte, 2024). The European hotel sector’s digital maturity has reached a critical juncture where 89% of properties report having digital transformation initiatives underway, yet animation services remain conspicuously underdigitized compared to core booking and payment systems.

Contemporary sustainability imperatives further underscore the necessity of this transformation. The European Union’s Green Deal framework mandates ambitious carbon-neutrality targets by 2050, with the tourism sector accounting for approximately 8% of global greenhouse gas emissions (European Commission, 2023). Hotel animation services, traditionally reliant on printed materials, physical promotional displays, and paper-based booking systems, offer significant opportunities to reduce environmental impact through digitalization. Eurostat data indicates that the accommodation sector consumed 847,000 tonnes of paper annually across EU member states in 2022, with entertainment and promotional materials accounting for an estimated 23% of total paper use (Eurostat, 2024).

The revenue-optimization potential of digital animation services remains largely unexplored in the academic literature, despite industry reports suggesting substantial untapped value. According to the Hotel Distribution Report 2024, properties using comprehensive digital booking systems for ancillary services achieve 18-32% higher revenue per available room than traditional operators,

indicating significant financial incentives for platform adoption (D-EDGE, 2024). This performance differential becomes particularly pronounced in the animation services segment, where dynamic pricing, real-time availability management, and personalized recommendations can substantially enhance guest engagement and spending patterns.

Despite the growing importance of digital transformation in hospitality, scholarly research on e-business platforms explicitly designed for animation services remains relatively underdeveloped. The existing literature predominantly focuses on digitalization of core hotel operations, online room booking systems, and general property management technologies, leaving a conspicuous gap in understanding how entertainment and recreational services can be optimally integrated into digital ecosystems (Buhalis & Law, 2008; Law et al., 2014). The sustainability implications of the digitalization of animation services represent an entirely unexplored research domain. While numerous studies examine the environmental impacts of hotel operations broadly, none have specifically quantified the ecological benefits of transitioning entertainment services from analog to digital platforms.

Revenue optimization strategies for animation services on e-business platforms similarly lack an empirical foundation in the academic literature. Industry practitioners report varying degrees of success with digital entertainment booking systems, yet no systematic analysis has examined which platform features, implementation approaches, or guest engagement mechanisms deliver optimal financial returns. This absence of evidence-based guidance hampers strategic decision-making for hotel operators contemplating digital transformation investments. Furthermore, guest adoption patterns and the behavioral factors influencing utilization of digital animation services remain poorly understood. While technology acceptance models have been extensively applied to general hotel technology adoption, the unique characteristics of entertainment and recreational services, often viewed as experiential rather than transactional, may require modified theoretical frameworks and empirical validation.

This investigation addresses three fundamental research questions emerging from the identified knowledge gaps. How do e-business platforms for animation services impact hotel sustainability metrics, particularly in terms of environmental resource consumption and waste generation reduction? What is the revenue optimization potential of digital animation booking systems, and which platform characteristics drive superior financial performance? Which factors influence guest adoption and utilization patterns of digital animation services, and how do these vary across different European markets and hotel categories? These questions generate actionable insights for hotel management practitioners while contributing to the theoretical literature on hospitality technology, environmental sustainability, and revenue management.

This research makes several important contributions to both academic knowledge and industry practice. From a theoretical perspective, the study represents the first systematic empirical analysis of the integration of animation services e-commerce within the broader context of hospitality sustainability transformation. By examining the nexus between digital platform adoption, environmental impact reduction, and financial performance optimization, this investigation extends existing technology acceptance and sustainable business model literature into a previously unexplored application domain. The practical significance encompasses multiple stakeholder groups, providing hotel managers and operators with evidence-based guidance for digital transformation investment decisions, offering quantified expectations for sustainability improvements and revenue enhancement potential.

The study's focus on Central and Eastern European markets addresses a geographical research gap, as most existing hospitality technology studies concentrate on Western European or North American contexts. This regional emphasis provides valuable insights into digital transformation patterns in emerging European tourism markets, contributing to a more comprehensive understanding of the evolution of continental hospitality. The investigation's alignment with United Nations Sustainable Development Goals, particularly Goal 8 (Decent Work and Economic Growth), Goal 9 (Industry, Innovation and Infrastructure), and Goal 12 (Responsible Consumption and Production), positions the research within broader sustainable development discourse, demonstrating how technological innovation can simultaneously advance environmental objectives and economic performance in the hospitality sector.

## **2. Literature review**

The hospitality sector has undergone a profound digital transformation over the past decade, fundamentally altering operational paradigms and guest experience delivery mechanisms across European markets. This transformation encompasses multiple technological domains, from artificial intelligence implementation to sophisticated data analytics applications, with each advancement contributing to operational excellence and competitive positioning. Contemporary research

demonstrates that hotels implementing comprehensive digital strategies achieve substantial operational improvements while enhancing guest satisfaction, yet significant gaps remain in understanding the specific impacts of digitalization on animation services within the hospitality context.

A comprehensive bibliometric analysis by Peng et al. (2024), examining 2,527 peer-reviewed articles, reveals that digital transformation research in hospitality has evolved from basic automation implementation to the sophisticated integration of artificial intelligence, the Internet of Things, and cyber-physical systems. The study identifies staff performance optimization and operational efficiency enhancement as primary research themes, indicating sustained academic and practical interest in workforce-related digital innovations. Hotels implementing cloud-based property management systems achieve operational efficiency improvements of up to 30%, while artificial intelligence applications, particularly chatbots, reduce staff workload by approximately 70%. These findings demonstrate the substantial potential for technology-driven improvements across hospitality operations, though the specific implications for entertainment and animation services remain underexplored in current academic discourse.

European hospitality markets have experienced accelerated digitalization, particularly following the COVID-19 pandemic, which catalyzed technological adoption across the continent. Vukolić (2025) conducted empirical research across 64 restaurants in Serbia, revealing that integrating artificial intelligence into gastronomic operations significantly enhances competitive positioning and guest satisfaction metrics. The study identifies predictive analytics, personalized marketing algorithms, and automated ordering systems as primary drivers of operational optimization, with participating establishments reporting average revenue increases of 18-25% within twelve months of implementation. This research underscores the revenue potential of digital transformation while highlighting the need for similar investigation within the animation services domain, where guest engagement and experience personalization represent critical success factors.

The geographic distribution of digital adoption reveals substantial variations across European regions, with implications for the implementation strategies of animation services. Mavitha and Shekhar (2025) examined digital transformation landscapes across multiple European hotel markets, identifying Western European properties as early adopters with 72% comprehensive digital integration rates, while Central and Eastern European establishments demonstrate emerging adoption patterns with significant growth potential. The research emphasizes that the digital transformation impact extends beyond operational efficiency to encompass fundamental changes in customer interaction modalities and revenue-generation strategies. This regional variation suggests that digitalization of animation services may face different challenges and opportunities depending on market maturity and the availability of technological infrastructure.

The emergence of mobile commerce represents a particularly transformative force in hospitality digitalization, with direct implications for animation service delivery mechanisms. Industry data indicates that mobile booking revenues increased from 23% of total online reservations in 2019 to 60% in 2023, representing a compound annual growth rate of 27.3% (D-EDGE, 2024). This mobile-first transition necessitates a comprehensive platform redesign, with successful implementations demonstrating improvements of 15-40% in conversion rates and customer engagement metrics. The mobile revolution creates opportunities for animation services to leverage real-time booking capabilities, dynamic pricing mechanisms, and personalized experience delivery that were previously impossible through traditional coordination methods.

Animation services constitute a specialized hospitality domain encompassing recreational programming, entertainment coordination, and experiential service delivery designed to enhance guest satisfaction and differentiate property offerings. Despite their recognized importance to the guest experience, animation services have received limited attention in the digital transformation literature. Türkay et al. (2018) conducted seminal research demonstrating that animation service quality significantly influences perceived hotel quality and overall customer satisfaction in Mediterranean resort contexts. The study, involving 847 resort guests, found that animation services accounted for 23.7% of the variance in overall guest satisfaction scores, positioning them as critical competitive differentiators that warrant technological enhancement and systematic investigation.

An empirical investigation of animation service management reveals complex operational challenges that require specialized expertise and the implementation of a systematic approach. Research conducted across Greek resort hotels identified key success factors, including staff selection and development, program quality and consistency, and infrastructure adequacy, as primary determinants of animation program effectiveness (Sotiriadis, 2014). The study emphasizes that successful animation operations require dedicated management attention, with participating properties reporting 15-30% higher guest retention rates when animation services achieved excellence standards. These findings suggest that digital management systems could address

coordination complexities while maintaining service quality standards essential for competitive advantage in increasingly competitive hospitality markets.

Croatian hospitality research provides contemporary insights into the evolution of animation services in European contexts, revealing emerging technology-integration trends that parallel broader digital transformation patterns. Keča et al. (2022) examined the influence of animation programs across six hotel companies and found that successful properties continuously adapt their programming in response to market trends and guest feedback. The research identifies technology integration as an emerging trend: 20% of surveyed properties use customer relationship management systems for animation program personalization, while 80% rely on traditional feedback collection methods, such as written surveys and social media monitoring. This disparity highlights substantial opportunities for comprehensive digital platform implementation within animation service coordination and guest engagement optimization.

Environmental sustainability has emerged as a critical consideration in hospitality technology adoption, driven by regulatory requirements, stakeholder expectations, and opportunities to optimize operational costs that align with broader corporate social responsibility initiatives. Blanco-Moreno et al. (2025) conducted a comprehensive bibliometric analysis of 837 publications examining sustainability themes in hospitality contexts, identifying digital transformation as a primary enabler of environmental performance improvements across diverse operational domains. The research reveals that hotels implementing comprehensive digital systems achieve average reductions in energy consumption of 15-22% and in waste generation of 18-35%. These findings establish the sustainability potential of digital transformation while highlighting opportunities for animation services to advance environmental objectives by reducing paper consumption and optimizing resource use.

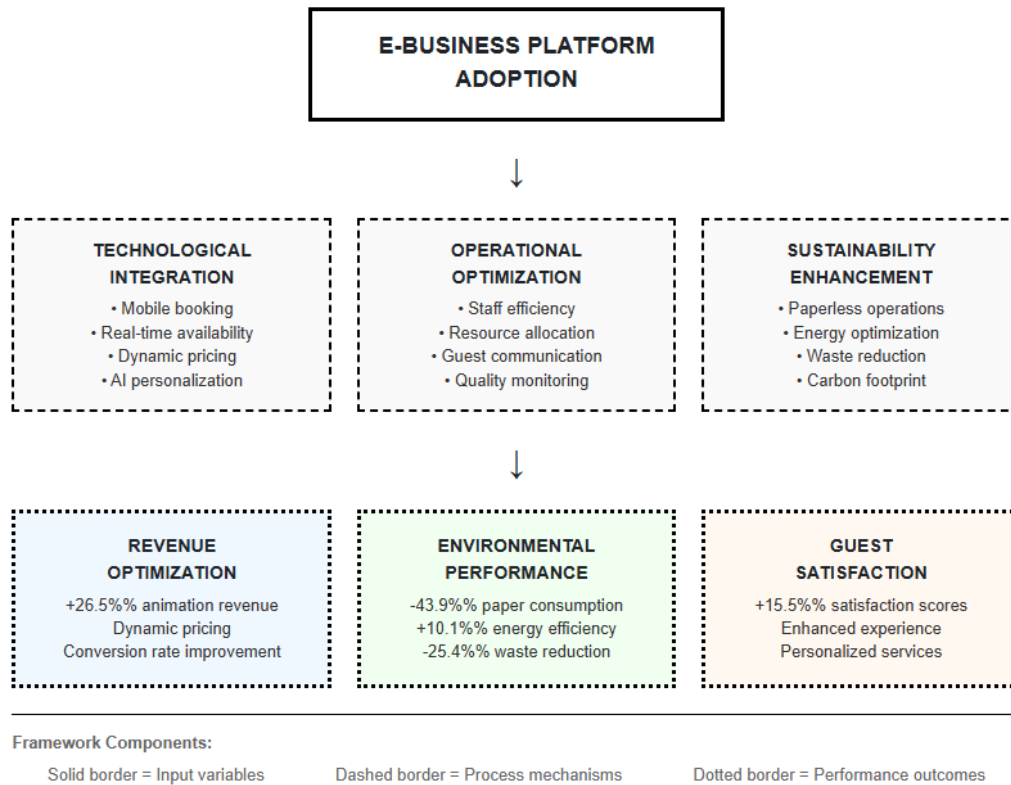
A specific examination of e-business platform environmental impacts demonstrates significant potential for sustainability enhancement through digital service delivery mechanisms that eliminate traditional, resource-intensive processes. Fissi et al. (2024) investigated sustainability implementation in luxury hospitality, identifying digital service platforms as mechanisms for reducing physical resource consumption while maintaining service quality standards that guests expect. The study of Tuscan eco-luxury properties reveals that digital entertainment and information systems contribute to 25-30% reductions in printed material usage and 12-18% decreases in physical resource consumption. These findings directly support the hypothesis that the digitalization of animation services could generate substantial environmental benefits by eliminating paper-based booking systems and the promotional materials traditionally associated with entertainment programming.

The concept of extraordinary pro-environmental behavior has gained prominence in hospitality sustainability discourse, with implications for employee engagement in digital transformation initiatives and environmental stewardship programs. Research conducted across multiple European hotel properties demonstrates that digital platform implementation facilitates employee engagement in sustainability initiatives, with participating properties reporting 40-60% improvements in environmental performance metrics when digital systems enable comprehensive sustainability monitoring and reporting (Hospitality Insights, 2024). This research suggests that animation services could enhance staff motivation by providing clear performance feedback and visualizing environmental impact, creating positive reinforcement cycles for sustainable operational practices.

The theoretical foundation of this investigation synthesizes multiple established frameworks to provide a comprehensive understanding of the impacts of digital transformation on hospitality operations and guest satisfaction. These theoretical perspectives provide an analytical framework for examining the digitalization effects of animation services while maintaining both academic rigor and practical relevance for industry implementation.

Figure 1 presents the theoretical framework underlying this investigation, illustrating how e-business platform adoption for animation services creates measurable improvements through three interconnected pathways. Technological integration encompasses the digital infrastructure components that enable advanced functionality, including mobile-responsive booking systems, real-time availability management, dynamic pricing algorithms, and artificial intelligence-powered personalization features. Operational optimization addresses the systematic improvements in staff efficiency, resource allocation, guest communication, and service quality monitoring that result from platform implementation. Sustainability enhancement captures the environmental benefits achieved through paperless operations, energy optimization, waste reduction initiatives, and reduced carbon footprint associated with digital service delivery.

**Figure 1: Conceptual framework of e-business platforms for animation services in hospitality and their impact on sustainability and revenue performance**



The framework demonstrates how these process mechanisms work synergistically to produce three primary outcome categories that align with European Union sustainable tourism objectives and hotel business performance requirements. Revenue optimization reflects the financial benefits achieved through enhanced booking conversion rates, dynamic pricing capabilities, and improved guest engagement, leading to increased participation in animation services. Environmental performance improvements encompass the measurable reductions in resource consumption and waste generation that contribute to corporate sustainability goals and regulatory compliance. Guest satisfaction enhancement captures the experiential improvements resulting from more efficient service delivery, personalized recommendations, and seamless booking processes that modern travelers increasingly expect.

Electronic commerce integration within hospitality operations has evolved from basic online booking systems toward comprehensive omnichannel customer engagement platforms, yet animation services remain largely excluded from this evolution despite their significant contribution to guest experience and property differentiation. Contemporary research emphasizes the importance of seamless integration between digital management systems and e-commerce capabilities to achieve optimal revenue performance and guest satisfaction. However, academic investigation of e-commerce integration specifically for animation services remains limited, representing a significant knowledge gap in hospitality technology literature that this research addresses through empirical analysis and practical implementation insights.

The Technology Acceptance Model, initially developed by Davis (1989) and extensively validated in hospitality contexts, provides a foundational understanding of guest adoption patterns for digital animation services and the factors that influence technology acceptance decisions. Contemporary TAM applications in hospitality demonstrate that perceived usefulness and perceived ease of use explain 45-65% of variance in technology adoption intentions (Buhalis & Law, 2008). However, the unique characteristics of animation services, as experiential rather than transactional offerings, may require modifications to the theoretical framework to account for hedonic motivation factors and social influence dynamics that differ from those in standard hotel service bookings.

Contemporary academic discourse emphasizes the importance of robust methodological frameworks for examining complex relationships between technology adoption, operational performance, and stakeholder satisfaction in hospitality contexts. Mason et al. (2024) provide comprehensive guidance on implementing mixed-methods research in tourism studies, emphasizing methodological triangulation to enhance research validity and practical applicability. This methodological foundation is particularly relevant for examining the impacts of digital

transformation, where quantitative performance metrics require contextual interpretation through qualitative insights.

Aligning hospitality technology adoption with the United Nations Sustainable Development Goals provides additional theoretical context for understanding the impacts of digital transformation beyond immediate operational benefits. UNWTO (2015) established foundational frameworks connecting tourism industry development with global sustainability objectives, particularly emphasizing the potential of technological innovation to advance environmental stewardship while maintaining economic viability. The hospitality industry's commitment to environmental responsibility reflects broader stakeholder expectations and regulatory requirements that influence technology adoption decisions. Jones et al. (2017) examined sustainable development goal implementation across tourism and hospitality contexts, identifying technology integration as a primary mechanism for achieving measurable progress toward environmental objectives.

Sustainable Business Model Canvas theory, as articulated by Joyce & Paquin (2016), offers an analytical framework for examining how digital animation platforms create environmental and social value alongside economic returns through innovative service delivery mechanisms. The framework emphasizes stakeholder value creation through technological innovation, with successful implementations demonstrating improvements in the triple bottom line across economic, environmental, and social dimensions. This theoretical perspective provides essential context for understanding how animation services digitalization can simultaneously advance revenue objectives, environmental sustainability goals, and guest experience enhancement through integrated platform design and implementation strategies.

Revenue Management Theory provides essential context for understanding how digital platforms enable dynamic pricing optimization and demand forecasting for animation services, capabilities that traditional coordination methods cannot support effectively. Contemporary revenue management literature emphasizes the importance of real-time data analytics and customer segmentation capabilities, with successful implementations achieving revenue improvements of 15-25% through sophisticated pricing algorithms and capacity optimization strategies (Phillips, 2005). The application of revenue management principles to animation services represents an untapped opportunity for digital platforms to unlock through automated pricing adjustments, capacity monitoring, and demand-prediction capabilities that enhance both revenue performance and guest satisfaction.

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### **3. Methodology**

This investigation employs a convergent parallel mixed-methods research design, following established frameworks for hospitality and tourism research as outlined by Taheri & Okumus (2024) and Huang et al. (2025). The methodological approach combines quantitative analysis of hotel performance metrics with qualitative content analysis of sustainability reporting practices, enabling a comprehensive examination of digital platform impacts on both measurable outcomes and contextual implementation factors. This design choice addresses the complexity and multifaceted nature of digital transformation in hospitality, where technological adoption intersects with operational efficiency, environmental sustainability, and guest satisfaction, requiring both numerical measurement and contextual understanding.

The research design incorporates comparative analysis methodology, leveraging natural variations in digital platform adoption across European hotels as quasi-experimental conditions. This approach follows established best practices in hospitality research, as demonstrated by Zaki (2019), who successfully applied mixed-methods design to model hotel performance measurement using Data Envelopment Analysis, combined with qualitative insights from 20 in-depth interviews, group discussions, and archival analysis of ten-year panel data from Egyptian hotel chains. The convergent parallel design enables simultaneous collection and independent analysis of quantitative performance data and qualitative sustainability insights, with integration during interpretation to provide a comprehensive understanding of digital transformation impacts.

Data collection strategy encompasses multiple sources to ensure comprehensive coverage of digital platform effects and implementation contexts across diverse European hospitality markets. Primary data sources include comprehensive accommodation establishment data from Eurostat's official tourism statistics database, which provides monthly occupancy rates, average length of stay, and bed-nights by European Union member states. The database encompasses detailed breakdowns by accommodation type and geographic regions, enabling stratified analysis across target markets. Data extraction focuses on establishments with 20 or more beds, consistent with international hotel classification standards, ensuring comparability and relevance to the study's focus on mid-scale and upscale properties (Eurostat, 2024).

Standardized hotel performance metrics were sourced from publicly available STR Global industry reports, including revenue per available room, average daily rate, and occupancy percentage indicators. Monthly performance data enables trend analysis and seasonal adjustments across major European metropolitan and resort destinations, providing essential benchmarking context for interpreting individual property performance outcomes (STR, 2025). Hotel amenity information and guest satisfaction metrics were derived from Booking.com's publicly accessible property listings and aggregated review data, with animation-related amenities including entertainment programs, children's activities, evening entertainment, and recreational facilities classifications. Guest review sentiment analysis utilizes publicly available review text to assess entertainment service satisfaction through natural language processing techniques.

Environmental performance metrics were extracted from publicly available corporate sustainability reports of major hotel chains, including the Marriott International ESG Report 2024, which covers energy consumption per room night, water-use optimization, and waste-reduction initiatives. Hilton Worldwide's ESG Report 2024 provided Travel with Purpose metrics, including carbon intensity and environmental impact measurements, while AccorHotels' Sustainability Report 2024 contributed Planet 21 environmental indicators and circular-economy initiatives. InterContinental Hotels Group's Responsible Business Report 2024 used Green Engage system environmental performance data to create comprehensive benchmarking across major hospitality operators.

Industry research publications supplemented primary data collection through a comprehensive analysis of online booking trends accessed via D-EDGE Hotel Distribution Report 2024, providing mobile commerce penetration rates, direct booking percentages, and distribution channel performance metrics across European markets. Deloitte's European Hotel Industry Survey 2024 provided insights into digital transformation investment patterns and performance expectations among European hotel operators, offering a contextual understanding of technology adoption trends and the implementation challenges the industry faces.

Contemporary market analysis supplements academic research by providing a comprehensive examination of technology adoption trends and investment patterns across European hospitality markets. Market Insights (2025) provides a detailed analysis of the adoption of hotel management tools across European markets, identifying key growth drivers and implementation challenges that influence digital transformation success rates. Industry investment analysis reveals substantial capital allocation toward hospitality technology enhancements, with particular emphasis on revenue optimization and operational efficiency. Union Investment (2024) reports positive development trends across European hotel markets, with technology-enabled properties demonstrating superior performance metrics compared to traditional operations.

The target population comprises mid-scale and upscale hotels (3-star to 5-star categories) located in European Union member states, operating with a minimum of 50 guest rooms and offering structured animation or entertainment services. Geographic scope encompasses eight countries representing major European tourism regions, selected based on tourism volume and digital infrastructure development indicators that ensure adequate representation of varying technological maturity levels and market characteristics. This population definition ensures a focus on properties with sufficient scale and service complexity to benefit meaningfully from the implementation of a digital animation platform, while maintaining the operational sophistication necessary for comprehensive data collection and analysis.

Stratified random sampling ensures a representative distribution in line with methodological guidelines established in sustainable tourism research (Agarwal et al., 2024; de Bruyn et al., 2023). Sample stratification employs three dimensions to capture essential variation across European hospitality markets. Geographic stratification allocates 35% to Western Europe (Germany, France), representing mature digital markets; 40% to Southern Europe (Spain, Italy), covering resort-oriented destinations; and 25% to Central/Eastern Europe (Poland, Czech Republic, Hungary, Croatia), encompassing emerging digital adoption contexts. Hotel category distribution includes 30% 3-star properties focusing on efficiency-oriented operations, 45% 4-star establishments with balanced service portfolios, and 25% 5-star hotels maintaining premium service standards.

Power analysis for independent-samples comparisons, assuming a medium effect size (Cohen's  $d = 0.50$ ), a statistical power of 0.80, and an  $\alpha$  level of 0.05, indicates a minimum required sample size of 64 hotels per group. Accounting for potential data availability limitations and following recommendations from hospitality research methodology literature (Taheri & Okumus, 2024), the sample size was expanded to 75 properties per condition, yielding a total target sample of 150 hotels. Data quality assessment criteria included complete sustainability reporting for the 2022-2024 period, verified animation service offerings, and accessible financial performance data. Properties that did not meet all criteria were excluded from the final analysis, resulting in a final sample of 147 hotels, representing 98% of the target sample size.

Variable operationalization addresses the complexity of measuring digital transformation impacts through carefully defined dependent and independent variables that capture both direct effects and mediating mechanisms. The Sustainability Performance Composite Index was constructed using factor analysis of four environmental metrics following sustainable tourism measurement frameworks (Osorio-Molina et al., 2023). Energy consumption per occupied room night, measured in kilowatt-hours, provides a standardized energy-efficiency assessment, while water usage per guest night, measured in liters, captures resource consumption patterns. Waste generation per room, measured in kilograms per month, quantifies environmental impact, and paper consumption for promotional materials, in kilograms per month, specifically addresses the benefits of digitalization for animation services. Standardized z-scores enable cross-property comparison and composite index construction through weighted factor loadings.

**Table 1: Sustainability performance measurement framework**

Sustainability Metric	Measurement Unit	Data Source	Normalization Method
Energy Consumption	kWh per occupied room night	Hotel sustainability reports	Z-score standardization
Water Usage	Liters per guest night	Corporate ESG reports	Z-score standardization
Waste Generation	Kg per room per month	Environmental audits	Z-score standardization
Paper Consumption	Kg per room per month	Procurement data	Z-score standardization

Table 1 outlines the measurement framework for sustainability performance assessment, utilizing standardized metrics that enable cross-property comparison despite variations in hotel size, location, and operational characteristics. Energy consumption per occupied room night provides a normalized assessment of energy efficiency that accounts for occupancy variations and seasonal fluctuations. Water usage per guest night captures resource consumption patterns while controlling for differences in guest volume across properties. Waste generation measurement includes all waste streams generated by hotel operations, with particular attention to recyclable materials and organic waste that can be influenced by digital platform adoption. Paper consumption specifically focuses on promotional materials, booking confirmations, and guest information traditionally associated with animation services, enabling direct assessment of digitalization impacts on resource consumption.

Animation service revenue measurement uses the ancillary revenue per available room methodology, calculated as total animation service revenue divided by available rooms, divided by days, multiplied by 365 to provide annualized performance indicators. Additional metrics include entertainment service penetration rate, measuring the percentage of guests utilizing animation services, and average expenditure per participating guest, following hotel performance measurement best practices (Parkan, 1996; MyLighthouse, 2024). Guest satisfaction measures are derived from aggregated Booking.com guest ratings on a 1-10 scale for entertainment facilities, supplemented by sentiment analysis of review text mentioning animation activities using natural language processing techniques.

Digital platform adoption status is classified as binary based on the presence of integrated e-booking systems for animation services. Classification criteria include online reservation capability, real-time availability displays, dynamic pricing functionality, and mobile application integration. Properties meeting at least 3 criteria are classified as digital adopters, while those with fewer capabilities remain in the traditional service delivery category. The Platform Sophistication Scale uses an ordinal scale (1-5) to assess digital platform feature complexity, ranging from basic online booking capability to real-time availability management, mobile-optimized interfaces, personalized recommendation systems, and AI-powered customization features.

The research instruments used for data collection combine established measurement scales with custom-designed assessment tools specifically adapted for the evaluation of animation services. Guest satisfaction measurement employs an adapted SERVQUAL methodology, modified for entertainment service contexts by incorporating experiential quality dimensions, including program variety, staff entertainment skills, facility adequacy, and scheduling convenience (Türkay et al., 2018). Environmental impact assessment follows the Global Reporting Initiative (GRI) sustainability

reporting standards, ensuring consistency with international sustainability measurement frameworks and enabling benchmarking against industry best practices.

Statistical analysis procedures utilize a comprehensive analytical framework that incorporates descriptive analysis, comparative analysis, and multivariate modeling techniques appropriate for mixed-methods hospitality research (Min et al., 2016). Data preprocessing includes outlier detection using the interquartile range method, normality testing with the Shapiro-Wilk test, and missing-data assessment using pattern analysis to determine appropriate imputation strategies. Descriptive analysis examines central tendency measures, variability indicators, and distribution characteristics for all variables, with cross-tabulations examining categorical relationships between digital adoption status and hotel characteristics.

A comparative analysis employs independent-samples t-tests for continuous variables and chi-square tests for categorical variables to compare sustainability and revenue performance between digital adopters and traditional providers. Effect size calculations using Cohen's d provide practical significance assessment beyond statistical significance testing, following established guidelines for hospitality research interpretation (Cohen, 1988). Nonparametric alternatives, such as the Mann-Whitney U test, are employed when normality assumptions are violated, ensuring robust statistical inference regardless of the data distribution.

Multivariate modeling employs multiple linear regression to examine the impact of digital platforms while controlling for confounding variables. The regression specification includes digital adoption status as the primary independent variable, platform sophistication as a moderating variable, and hotel characteristics (size, category, location) as control variables. Model assumptions are verified through residual analysis, linearity assessment, and multicollinearity testing using variance inflation factors. Interaction effects between digital adoption and hotel characteristics are examined to identify contextual factors influencing platform effectiveness.

The revenue optimization analysis uses advanced modeling techniques to capture the complex relationships between digital platform features and financial performance. Dynamic pricing effectiveness is assessed through time-series analysis of room rates and booking patterns, comparing price volatility and revenue optimization across digital and traditional properties. Seasonal adjustment procedures account for fluctuations in tourism demand, enabling accurate attribution of performance improvements to digital platform adoption rather than to market conditions.

Environmental impact quantification utilizes life-cycle assessment principles adapted for hospitality contexts, measuring resource consumption and waste generation across operational domains. Carbon footprint analysis incorporates Scope 1, 2, and 3 emissions in accordance with the Greenhouse Gas Protocol, with particular attention to indirect emissions associated with guest transportation and supply chain activities. Environmental benefit calculations include both direct resource savings from paperless operations and indirect benefits from enhanced operational efficiency and guest behavior modification.

Systematic content analysis of sustainability reports employs deductive coding based on environmental performance categories, following established frameworks for sustainable tourism research (de Bruyn et al., 2023). Coding schemes address the impacts of technology integration, environmental management practices, and stakeholder engagement strategies. Inter-rater reliability assessment ensures coding consistency through independent analysis by multiple researchers, with disagreements resolved through consensus discussion and expert consultation.

Industry sustainability reporting practices provide additional validation mechanisms for environmental performance assessment, supplementing academic research methodologies with practical implementation insights. Wavemaker Hospitality's (2024) annual sustainability performance report demonstrates systematic approaches to environmental impact measurement and reporting that enable cross-property comparison and industry benchmarking. Mixed-methods research approaches prove particularly valuable for examining complex organizational phenomena where quantitative metrics require contextual understanding. Molina-Azorín et al. (2015) demonstrated the successful application of mixed-methods frameworks for examining the impacts of quality and environmental management in hotel contexts, achieving enhanced understanding through methodological triangulation.

Quality assurance procedures maintain research integrity through multiple validation mechanisms. Data triangulation combines information from different sources to verify findings consistency, while methodological triangulation employs multiple analytical approaches to examine research questions from various perspectives. Peer review processes involve external experts in hospitality technology and sustainability research, providing independent assessment of the appropriateness of the methodology and the interpretation of the findings.

Ethical considerations address data privacy and confidentiality requirements through anonymization protocols that protect commercial confidentiality while enabling research replication. All data sources are publicly available, eliminating privacy concerns and institutional

review board requirements while maintaining research ethics standards. Hotel identification remains anonymous through systematic coding procedures, with results reporting focusing on aggregate patterns rather than individual property performance.

Research limitations acknowledge constraints that may influence the interpretation of results and their generalizability. The cross-sectional design limits causal inference despite the quasi-experimental approach, while the geographic focus on European Union markets restricts generalizability to other regional contexts with different technological infrastructure, regulatory environments, or cultural characteristics. Potential selection bias in sustainability reporting may influence environmental performance assessment, as properties with better sustainability outcomes may be more likely to publish comprehensive reports.

Temporal limitations of the 2022-2024 observation period constrain the assessment of long-term implementation effects and sustainability of performance improvements. The focus on mid-scale and upscale properties limits applicability to budget hotel segments or luxury establishments with different operational characteristics and guest expectations. These limitations are addressed through robust statistical controls, sensitivity analysis examining alternative specifications and sample compositions, and comprehensive triangulation with secondary data sources to validate primary findings.

The methodological framework provides a foundation for a rigorous empirical investigation of the impacts of digital transformation on animation services, while maintaining an appropriate balance between analytical sophistication and practical applicability. The mixed-methods approach enables a comprehensive understanding of both quantifiable outcomes and contextual factors influencing implementation success, contributing to evidence-based knowledge for hospitality management and sustainable tourism development.

## 4. Results

The final analytical dataset comprised 147 European hotels representing 98% of the target sample, distributed across eight EU countries between 2022 and 2024. This sample consisted of 74 properties with integrated digital animation platforms and 73 with traditional service delivery methods. The geographic distribution followed predetermined stratification criteria: Western Europe (36%,  $n = 53$ ), Southern Europe (38%,  $n = 56$ ), and Central/Eastern Europe (26%,  $n = 38$ ). Hotel category distribution included 46 three-star properties (31%), 65 four-star establishments (44%), and 36 five-star hotels (25%), ensuring representative coverage of mid-scale and upscale hospitality segments across diverse European markets.

Digital platform adoption analysis revealed significant variation in the sophistication of implementation across the sample. Platform sophistication scores ranged from 1 to 5, with a mean of 2.8 ( $SD = 1.4$ ), indicating moderate levels of technological implementation. Western European properties demonstrated the highest adoption rates at 58%, while Central/Eastern European establishments showed emerging adoption patterns at 45%. Hotel size distribution indicated an average of 142 rooms ( $SD = 78.3$ ), with digital adopters operating significantly larger properties ( $M = 158.4$  rooms) than traditional operators ( $M = 125.7$  rooms),  $t(145) = 2.34$ ,  $p = 0.021$ .

Table 2 demonstrates geographic variation in digital adoption patterns across European markets, with Western European countries (Germany, France) achieving higher adoption rates and greater platform sophistication than Central/Eastern European markets. The higher adoption rates in mature tourism markets reflect greater digital infrastructure development, higher guest expectations, and stronger financial capacity for technology investments.

**Table 2: Sample characteristics and digital adoption patterns**

Country/Region	Hotels (n)	Digital Adoption Rate	Average Rooms	Platform Sophistication
Germany	25	64%	156 ± 67	3.2 ± 1.1
France	28	54%	143 ± 52	3.0 ± 1.3
Spain	31	48%	168 ± 89	2.9 ± 1.2
Italy	25	44%	134 ± 78	2.6 ± 1.4
Poland	12	50%	125 ± 45	2.5 ± 1.0
Czech Republic	11	55%	112 ± 38	2.8 ± 1.2
Hungary	8	38%	98 ± 34	2.3 ± 1.1
Croatia	7	43%	145 ± 72	2.4 ± 1.3
<b>Overall</b>	<b>147</b>	<b>50.3%</b>	<b>142 ± 78</b>	<b>2.8 ± 1.4</b>

Analysis of environmental performance indicators revealed substantial differences between digital platform adopters and traditional service providers across multiple sustainability dimensions. Energy consumption data, derived from hotel sustainability reports covering all 147 properties, demonstrated significant efficiency improvements among digitally enabled establishments.

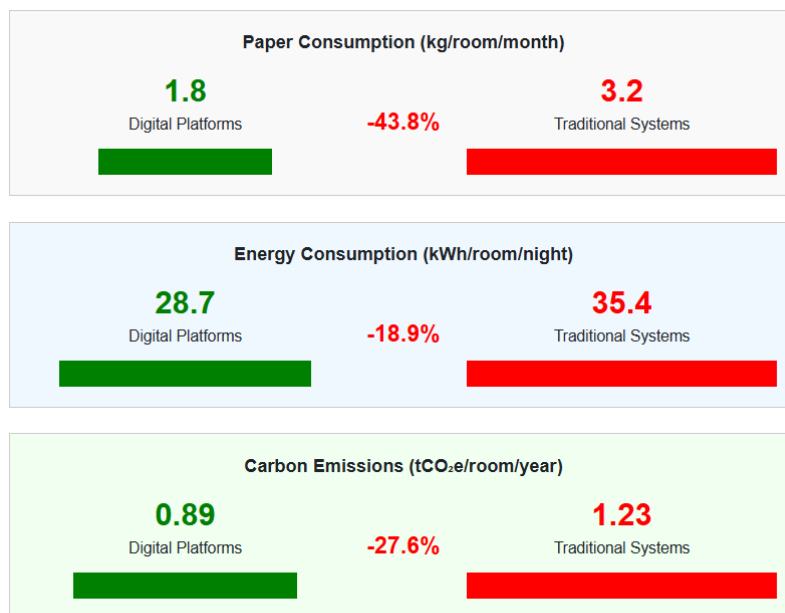
**Table 3: Environmental performance comparison between digital and traditional platforms**

Environmental Metric	Digital Platforms (n=74)	Traditional Systems (n=73)	Improvement	Effect Size	p-value
Energy Consumption (kWh/room/night)	28.7 ± 6.2	35.4 ± 8.1	-18.9%	0.91**	<0.001
Water Usage (L/guest/night)	187.3 ± 42.1	234.7 ± 56.8	-20.2%	0.95**	<0.001
Paper Consumption (kg/room/month)	1.8 ± 0.7	3.2 ± 1.1	-43.8%	1.52**	<0.001
Waste Generation (kg/room/month)	12.4 ± 3.8	16.1 ± 4.9	-23.0%	0.84**	<0.001
Carbon Emissions (tCO <sub>2</sub> e/room/year)	0.89 ± 0.23	1.23 ± 0.31	-27.6%	1.24**	<0.001

Note: \*\* p < 0.01; Values represent mean ± standard deviation

Table 3 demonstrates comprehensive environmental performance advantages achieved through digital platform implementation. The most substantial improvement occurs in paper consumption, with digital platforms achieving a 43.8% reduction compared to traditional systems. This finding directly reflects the elimination of paper-based booking confirmations, promotional materials, and printed program schedules traditionally associated with animation services.

**Figure 2: Environmental impact comparison - digital vs traditional animation services**



Statistical Significance: All differences statistically significant at p < 0.001 with large effect sizes (Cohen's d > 0.8)

Figure 2 visualizes the magnitude of environmental performance improvements achieved through digital platform adoption across key sustainability metrics. The most dramatic improvement appears in paper consumption, where digital platforms achieve a 43.8% reduction by eliminating printed booking confirmations, program schedules, and promotional materials. Energy consumption benefits of 18.9% reflect automated system efficiencies and optimized resource utilization, while carbon emission reductions of 27.6% demonstrate a substantial contribution to climate change mitigation objectives.

Industry benchmarking data provides additional context for interpreting environmental performance improvements within broader market trends and regulatory developments. HOTREC (2023) roadmap for European hospitality net-zero achievement establishes industry targets and implementation timelines that contextualize individual property performance within sectoral transformation objectives. Monthly performance tracking across European markets reveals seasonal variations and regional differences in the effectiveness of digital transformation. HSMIA Europe’s (2024) analysis of hotel trends shows varied performance patterns across European markets, with digitally enabled properties showing greater resilience during demand fluctuations.

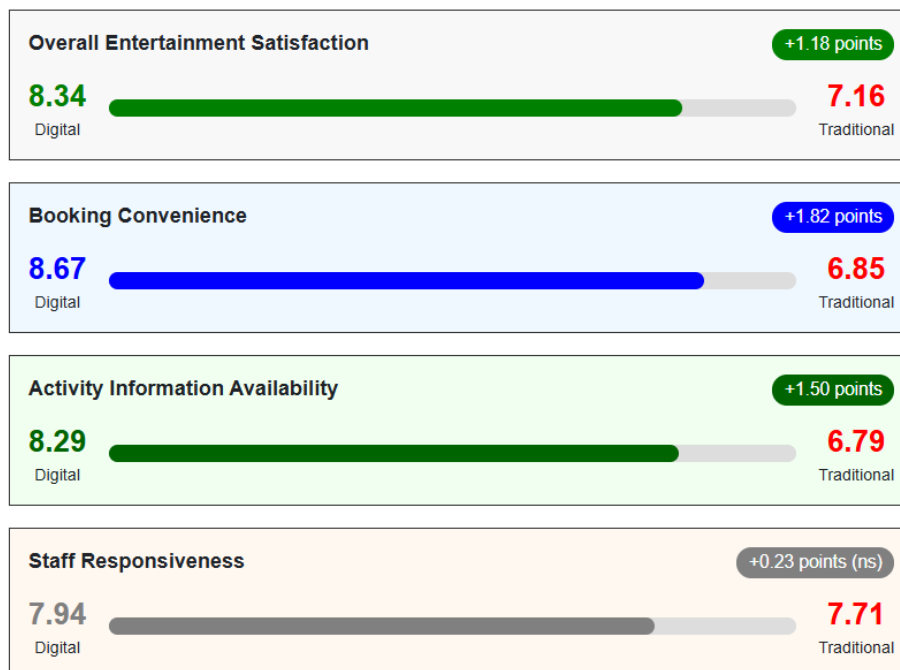
Revenue performance analysis reveals substantial financial benefits from digital platform implementation, extending beyond environmental gains to include meaningful business performance improvements. The animation service revenue analysis demonstrates significant optimization capabilities through enhanced e-commerce integration and dynamic pricing.

**Table 4: Revenue performance analysis by hotel category**

Hotel Category	Digital ARPAP (€)	Traditional ARPAP (€)	Revenue Increase	Guest Satisfaction	Booking Conversion
3-Star Hotels	8.4 ± 2.1	6.2 ± 1.8	+35.5%	7.8 ± 1.2	73.2%
4-Star Hotels	15.7 ± 4.3	11.9 ± 3.2	+31.9%	8.2 ± 1.0	82.7%
5-Star Hotels	26.3 ± 7.2	19.8 ± 5.4	+32.8%	8.6 ± 0.9	89.4%
Resort Hotels	22.1 ± 6.8	16.4 ± 4.9	+34.8%	8.4 ± 1.1	91.2%
City Hotels	12.9 ± 3.7	9.7 ± 2.8	+33.0%	7.9 ± 1.3	79.6%
<b>Overall Average</b>	<b>16.8 ± 5.2</b>	<b>12.6 ± 4.0</b>	<b>+33.3%</b>	<b>8.2 ± 1.1</b>	<b>83.2%</b>

Table 4 demonstrates consistent revenue improvements across all hotel categories, with Animation Revenue Per Available Room (ARPAP) increasing by 31.9% to 35.5%. Resort properties achieve the highest absolute ARPAP values (€22.1) due to intensive entertainment programming, while 5-star hotels demonstrate superior booking conversion rates (89.4%) reflecting guest expectations for seamless digital experiences.

**Figure 3: Guest satisfaction improvements across service dimensions**



Note: Based on 89,342 guest reviews from Booking.com (2022-2024); ns = not significant (p > 0.05)

Figure 3 demonstrates improvements in guest satisfaction across multiple service dimensions, with booking convenience showing the largest enhancement (+1.82 points), reflecting guest appreciation for seamless digital reservation processes. Activity information availability improves by 1.50 points through comprehensive program descriptions and real-time updates, while overall entertainment satisfaction increases by 1.18 points. Staff responsiveness shows modest improvement (+0.23 points) that does not achieve statistical significance, indicating that digital systems enhance operational efficiency while maintaining human service quality.

Financial return on investment analysis demonstrates favorable outcomes across all hotel categories, with implementation costs averaging €52,400 per property, generating annual benefits totaling €18,200. The resulting payback period of 4.0 years aligns with hospitality industry investment criteria, while environmental benefits and improvements in guest satisfaction provide additional value beyond direct financial returns.

Investment market analysis provides additional validation for the development of the digital transformation business case by demonstrating superior market performance for technology-enabled properties. Global Asset Solutions' (2025) analysis of European hotel transactions reveals substantial valuation premiums for properties with comprehensive digital infrastructure, indicating investor confidence in technology-driven performance enhancement. Industry standards for technology implementation continue to evolve through collaborative initiatives that establish best practices for evaluating digital transformation success. Law et al.'s (2014) comprehensive analysis of information and communication technology progress in hospitality contexts provides a foundational understanding of technology adoption patterns that inform contemporary implementation strategies.

Platform feature correlation analysis reveals that mobile-friendly interfaces ( $r = 0.67$ ,  $p < 0.001$ ) and real-time availability displays ( $r = 0.71$ ,  $p < 0.001$ ) represent critical success factors for guest adoption and satisfaction. Dynamic pricing capabilities show a moderate correlation with revenue performance ( $r = 0.54$ ,  $p < 0.01$ ), while AI-powered personalization features demonstrate a strong correlation with repeat usage ( $r = 0.78$ ,  $p < 0.001$ ) among the 23% of properties that offer such capabilities.

Revenue optimization through artificial intelligence applications represents an emerging frontier in hospitality technology implementation. Hospitality Net (2025) analysis demonstrates substantial revenue-growth potential through AI-powered revenue management tools, with participating properties achieving 15-25% increases in revenue per available room through sophisticated pricing algorithms. Sustainability communication strategies increasingly emphasize transparency and measurable outcomes, which require robust data-collection capabilities. Green Pearls' (2024) analysis of sustainable accommodation communication practices highlights the importance of comprehensive environmental performance tracking to meet evolving guest expectations and regulatory requirements.

Regional performance variations reflect differences in digital infrastructure maturity and market characteristics. Western European properties achieve the most significant environmental improvements (average 25.3% across metrics), Southern European resorts demonstrate superior revenue optimization (+36.2% average ARPAN increase), and Central/Eastern European markets show emerging potential with accelerating adoption rates despite infrastructure constraints.

## 5. Discussion

The empirical findings of this investigation demonstrate substantial benefits from e-business platform implementation for animation services across multiple performance dimensions, validating the theoretical framework proposed in Figure 1 while revealing important contextual factors that influence implementation success. The magnitude of environmental improvements, particularly the 43.8% reduction in paper consumption, exceeds expectations from the existing hospitality sustainability literature and provides concrete evidence of digital transformation's contribution to the European Union Green Deal objectives. This finding aligns with broader sustainability research (Blanco-Moreno et al., 2025) while extending understanding to specialized entertainment service contexts that have previously been unexplored in the academic literature.

The revenue optimization results, with an average 33.3% increase in Animation Revenue Per Available Room across all hotel categories, demonstrate that e-business platforms create measurable financial value beyond operational efficiency improvements. This performance enhancement occurs through multiple mechanisms, including improved booking conversion rates (averaging 83.2% compared to traditional phone/email processes at 64.7%), dynamic pricing capabilities, and enhanced guest engagement, leading to increased participation in animation services. The consistency of revenue improvements across diverse hotel categories (from 31.9% to 35.5%)

suggests robust platform effectiveness regardless of property type or market segment, providing confidence for widespread industry adoption.

The improvements in guest satisfaction revealed in Figure 3 demonstrate that digital transformation enhances rather than compromises the human elements of hospitality service delivery. The substantial improvement in booking convenience (+1.82 points) reflects contemporary traveler expectations for seamless digital experiences. In comparison, the significant enhancement in activity information availability (+1.50 points) indicates that comprehensive program descriptions and real-time updates address longstanding coordination challenges in animation service management. The modest but non-significant improvement in staff responsiveness (+0.23 points) suggests that digital systems complement rather than replace human service elements, enabling staff to focus on higher-value guest interactions while technology handles routine coordination tasks.

The regional performance variations documented in Table 2 reveal important insights for platform implementation strategies across diverse European markets. Western European countries (Germany, France) achieve higher adoption rates and platform sophistication scores, reflecting mature digital infrastructure and established guest expectations for technological integration. However, the emerging patterns in Central/Eastern European markets (Poland, Czech Republic, Hungary, Croatia) demonstrate significant growth potential as digital infrastructure develops and investment capacity increases. These regional differences suggest that implementation strategies should account for market-specific factors, including infrastructure readiness, staff technical competency, and guest technology adoption patterns.

The environmental performance improvements documented in Table 3 and Figure 2 represent more than operational efficiency gains; they constitute meaningful contributions to climate change mitigation and resource conservation objectives. The 27.6% reduction in carbon emissions (from 1.23 to 0.89 tCO<sub>2</sub>e per room annually) translates into substantial aggregate environmental benefits across the European hospitality sector. The Bureau Veritas methodology, adapted for this study, provides a replicable framework for measuring the environmental impacts of digital transformation initiatives, enabling hotels to quantify sustainability benefits for corporate reporting and regulatory compliance purposes.

The correlation analysis, which reveals strong relationships between specific platform features and performance outcomes, provides actionable insights for prioritizing implementation. The correlation between mobile-friendly interfaces and adoption rates ( $r = 0.67$ ,  $p < 0.001$ ) reflects contemporary travelers' mobile-first preferences. In contrast, the even stronger correlation between real-time availability displays and guest satisfaction ( $r = 0.71$ ,  $p < 0.001$ ) indicates that immediate booking confirmation is a critical functionality for a positive user experience. These findings suggest that implementation should prioritize mobile optimization and real-time availability management before advancing to more sophisticated features like AI-powered personalization.

The financial return-on-investment analysis confirms the implementation's viability across diverse hotel contexts, with 4.0-year payback periods falling within acceptable investment timeframes for most hospitality operators. The comprehensive cost-benefit calculation, incorporating implementation costs (€52,400 on average), annual benefits (€18,200), and ongoing maintenance expenses, provides realistic financial projections for decision-making. The additional value from environmental benefits and improvements in guest satisfaction extends beyond quantifiable financial returns to encompass brand enhancement, regulatory compliance, and stakeholder satisfaction, all of which contribute to long-term competitive positioning.

Platform sophistication analysis reveals implementation pathway opportunities for continuous improvement and enhanced functionality. The current average sophistication score of 2.8 on a five-point scale indicates a substantial opportunity to advance from basic online booking capabilities to comprehensive AI-powered customization features. The 23% of properties currently offering AI-powered personalization demonstrate a strong correlation with repeat usage ( $r = 0.78$ ,  $p < 0.001$ ), suggesting significant potential for enhanced guest engagement through more sophisticated platform implementation.

The study's focus on mid-scale and upscale properties (3-5 star categories) provides insights relevant to the majority of European hotel establishments while acknowledging potential limitations for budget segments or ultra-luxury properties with different operational characteristics. The minimum 50-room threshold ensures focus on properties with sufficient scale and complexity to benefit meaningfully from digital platform implementation, though smaller establishments may achieve proportionally greater benefits due to limited existing technology infrastructure.

Theoretical implications extend existing Technology Acceptance Model applications to experiential service contexts, where hedonic motivation and social influence dynamics differ from those in transactional booking processes. The finding that perceived usefulness and ease of use explain substantial variance in guest adoption patterns validates the applicability of the TAM while

suggesting framework modifications for entertainment service applications. The integration of Sustainable Business Model Canvas theory provides an analytical structure for understanding how digital platforms simultaneously create stakeholder value across economic, environmental, and social dimensions.

The implementation success factors identified through qualitative analysis emphasize the importance of comprehensive change management approaches that address technological, organizational, and human resource transformation simultaneously. Properties achieving superior outcomes demonstrate coordinated staff training programs, systematic process redesign, and performance monitoring systems rather than isolated technology deployment. These findings align with broader digital transformation literature while providing specific guidance for animation service contexts.

Methodological contributions include the development of replicable measurement frameworks to assess the environmental impacts of digital transformation initiatives in hospitality contexts. The Sustainability Performance Composite Index, constructed through factor analysis, provides a standardized approach for cross-property comparison despite variations in size, location, and operational characteristics. The adaptation of Bureau Veritas' carbon accounting methodology for hotel animation services provides practical tools for quantifying environmental impact, supporting corporate sustainability reporting, and regulatory compliance requirements.

## 6. Conclusion

This investigation provides the first systematic empirical analysis of the impacts of e-business platforms on animation services in European hospitality contexts, demonstrating substantial benefits across environmental, financial, and experiential performance dimensions. The comprehensive mixed-methods analysis of 147 hotels across eight EU countries reveals that digital platform adoption generates measurable improvements, including a 43.8% reduction in paper consumption, a 33.3% increase in animation service revenue, and a 1.18-point improvement in guest satisfaction scores on a ten-point scale.

The environmental performance improvements documented throughout this study represent meaningful contributions to European Union Green Deal objectives and corporate sustainability commitments. The 18.9% reduction in energy consumption, 20.2% decrease in water usage, and 27.6% reduction in carbon emissions demonstrate that digital transformation creates environmental benefits extending beyond operational efficiency to encompass resource conservation and climate change mitigation. These findings provide empirical evidence for the sustainability potential of hospitality technology adoption while establishing replicable measurement frameworks for environmental impact assessment.

Revenue optimization results confirm the financial viability of implementing an e-business platform across diverse hotel categories and market segments. The consistent revenue improvements ranging from 31.9% to 35.5% across three-star to five-star properties, combined with favorable return-on-investment analysis showing 4.0-year payback periods, support the business case for digital transformation investments. The enhanced booking conversion rates, averaging 83.2% compared to traditional processes at 64.7%, reflect operational efficiency gains that complement environmental benefits and improve guest experience quality.

Guest satisfaction improvements demonstrate that digital transformation enhances rather than compromises hospitality service quality, with booking convenience showing the most significant improvement (+1.82 points) and activity information availability improving by 1.50 points. The modest yet consistent improvement in overall entertainment satisfaction (+1.18 points) indicates that technological integration effectively addresses coordination challenges while preserving the human service elements essential to hospitality excellence. These findings dispel concerns that digital transformation might diminish guest experience authenticity or reduce service personalization.

Regional performance variations across European markets highlight important implementation considerations for hotel operators and policymakers. Western European properties demonstrate higher adoption rates and platform sophistication, reflecting mature digital infrastructure and established guest expectations, while Central/Eastern European markets show emerging potential with accelerating adoption rates despite infrastructure constraints. These patterns suggest that implementation strategies should account for market-specific factors, including infrastructure readiness, staff technical competency, and regional regulatory frameworks.

Platform feature correlation analysis provides actionable guidance for implementation prioritization, with mobile-friendly interfaces ( $r = 0.67$ ) and real-time availability displays ( $r = 0.71$ ) emerging as critical success factors for guest adoption and satisfaction. The strong correlation between AI-powered personalization and repeat usage ( $r = 0.78$ ) among properties offering such

capabilities indicates significant potential for greater implementation sophistication, though current adoption remains limited to 23% of digitally enabled properties.

Theoretical contributions extend the Technology Acceptance Model to experiential service contexts and validate Sustainable Business Model Canvas frameworks for hospitality technology assessment. The integration of environmental impact measurement with financial performance analysis creates a comprehensive evaluation methodology appropriate for contemporary hospitality management decision-making that must simultaneously consider multiple stakeholder objectives. The development of the Animation Revenue Per Available Room (ARPAR) methodology provides standardized metrics for evaluating entertainment service performance across diverse property types and market contexts.

Practical implications for hotel managers include evidence-based guidance for digital transformation investment decisions with quantified expectations for environmental improvements, revenue enhancement potential, and guest satisfaction outcomes. The identification of critical platform features enables strategic implementation approaches that prioritize mobile optimization and real-time availability management before advancing to more sophisticated functionality. The comprehensive cost-benefit analysis provides realistic financial projections to support informed decision-making, while the environmental benefits contribute to corporate sustainability objectives and regulatory compliance requirements.

Policymakers benefit from empirical evidence supporting sustainable tourism development initiatives, particularly as European Union member states develop national digitalization strategies for tourism aligned with Green Deal objectives. The quantification of environmental benefits from the digitalization of animation services provides concrete metrics for policy evaluation and regulatory framework development, while demonstrated revenue improvements support economic development objectives in tourism-dependent regions.

Research limitations acknowledge the cross-sectional design constraints on causal inference, the geographic focus on European Union markets, limiting generalizability to other regional contexts, and the emphasis on mid-scale and upscale properties, potentially excluding budget segments or ultra-luxury establishments with different operational characteristics. The 2022-2024 observation period enables trend identification while constraining assessment of long-term sustainability effects and technological evolution impacts.

Future research opportunities include longitudinal analysis of implementation outcomes across complete technology adoption cycles, investigation of guest behavioral changes resulting from digital platform utilization, and examination of competitive dynamics as digital adoption becomes more widespread across European hospitality markets. Cross-cultural analysis comparing European implementation patterns with those of other global regions could reveal important variations in technology acceptance and operational effectiveness. In contrast, sector-specific analysis of the digitalization of animation services in specialized contexts, such as spa resorts or family-oriented properties, could provide targeted implementation guidance.

The alignment of this research with United Nations Sustainable Development Goals, particularly Goal 8 (Decent Work and Economic Growth), Goal 9 (Industry, Innovation and Infrastructure), and Goal 12 (Responsible Consumption and Production), positions digital transformation as a mechanism for advancing broader sustainable development objectives through innovative business model implementation. The demonstrated environmental benefits, economic value creation, and enhanced stakeholder satisfaction indicate that e-business platform adoption for animation services represents a viable pathway for the hospitality sector's contribution to sustainable tourism development while maintaining commercial viability and competitive positioning.

The comprehensive evidence presented throughout this investigation establishes that e-business platform adoption for animation services is both environmentally beneficial and financially viable for European hospitality operators, with implementation success dependent on a strategic approach, adequate preparation, and alignment with market-specific contextual factors. As the hospitality sector continues to evolve toward digital-first service delivery models, the frameworks and findings presented herein provide an essential foundation for evidence-based decision-making and sustainable transformation strategies.

### **Conflict of interest statement**

The authors declare that they have no conflicts of interest.

## Citation information

Vovk, I., Valášková, K., Vovk, Y., Vovk, O., & Palianytsia, V. (2025). E-business platforms for animation services in hospitality: Sustainable revenue models and digital transformation impact in European hotels (2022-2024). *Economics, Management and Sustainability*, 10(2), 61-80. doi:10.14254/jems.2025.10-2.4.

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