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A systematic literature review on green technology adoption in hotels bridging digital technologies and sustainability operations

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Abstract

Despite growing intellectual interest in green technology in hotels, the previous reviews have been dominated by answering ‘what’ are the factors influencing green technology adoption, rather than ‘why’ and ‘how’. The study filled the gap by examining the adoption of green technology in hotels by employing the integrated TCM (Theories, Contexts, Methods) and ADO (Antecedents, Decisions, Outcomes) framework. This review investigates digital technologies such as IoT-based water process monitoring, AI-enabled energy management, and smart automation, and discusses how they contribute to the sustainability outcomes in hotel operations. TCM analyzes theoretical landscape, methodological inconsistencies, and research settings, whereas ADO analyzes and resonates with the cause-action-result structure of the studied constructs concerning green technology. The study examined 62 articles from widely accepted Scopus and Web of Science databases and considered publications for the last 15 years (2010 to 2025). The analysis found that green technology research is dominated by sustainability theories and cross-sectional quantitative methods. In addition, research is mostly conducted in developed economies. The ADO analysis highlighted that organizational resources acted as the primary driver, and green technology adoption was the major decision variable, whereas environmental performance was the key outcome factor in the process structure. Through examining literature evaluation and framework-based analysis, the study contributes by bridging the gap between theoretical abstraction (macro level) and practical realities (micro level), providing insights for researchers and practitioners, and outlining critical future research directions.

Keywords: *Green Technology Adoption, Hospitality Industry, Sustainability, Systematic Literature Review, TCM-ADO Framework, Digital transformation, Industry 4.0*

1. Introduction:

The tourism and hospitality sector is a major and dominant sector contributing 9.1% of the world's GDP and 10% of all jobs in the world (Velasco-Muñoz et al., 2025). However, this industry, which is responsible for substantial greenhouse gas emissions, is considered the fifth largest pollution source in the world (Ali et al., 2023). According to the World Tourism Organization (UNWTO), tourism-related CO2 emissions may increase by 25% over 2016 levels by 2030, and global tourism-related emissions are expected to at least double from 2005 to 2035 (UNWTO, 2021). The hotels are responsible for a considerable carbon footprint, waste generation, and environmental degradation through their operational activities (Khalil et al., 2024; Menegaki & Agiomirgianakis, 2019; Nathaniel et al., 2023).

In this connection, several broader industrial concepts informed the environmental innovation in diverse sectors. Cleaner production, design for the environment (DfE), and reverse logistics ideas have long been used across industries to ensure sustainability. Cleaner production highlights preventive waste and emission reduction at the source level. For example, closed-loop polymer recycling has shown effectiveness in pollution reduction (over 3.5 million kg less pollution) and monthly savings (approx. BRL $75,384) (Oliveira Neto et al., 2015). DfE emphasizes product and process design to minimize environmental impact. For example, after applying DfE, a wind turbine minimized environmental impact by 62% and manufacturing costs by 61% (de Paoli & Lucato, 2014). Similarly, the concept of " reverse logistics' prioritizes the recovery and reuse of materials. Studies found it economically beneficial in supermarket retail (ROI 46%) and in the textured glass sector (monthly profit of BRL 293,100) (Oliveira Neto & de Sousa, 2014; Oliveira Neto et al., 2014). This evidence signals that industries are moving towards circular economy models (Aryee, 2025) and confirms the green technology adoption benefits in hotels that stress the utilization of energy and resources.

Recently, Industry 4.0 technologies (such as Internet of Things (IoT), Digital twins, Artificial Intelligence (AI), autonomous robots, big data, etc.) have been increasingly considered as a precondition for circular economy practices. For instance, these technologies moderately promote circular economy and cleaner production in the textile

sector by improving waste reduction, ensuring proper resource use, and enforcing recycling (Oliveira Neto et al., 2023a; Oliveira Neto et al., 2025). However, these studies mentioned that Industry 4.0 technologies ensure micro-level circularity, not the full ‘strong sustainability’. That means it often ignores issues such as fair worker treatment or local community well-being. This evidence is also critical for hotels applying green technologies in determining whether these technologies make hotels sustainable or just moderate improvements.

Since the 1990s, awareness and initiatives aimed at establishing 'green' hotels have gained increasing attention within the hospitality industry (Khatter, 2025; Haq et al., 2023) and the adoption of green technology practices has become a prominent focus for hotels. Eco-friendly technology in the hotel industry is defined as the utilization of green technology in hotel operations and applying it to all processes. (Akel & Noyan, 2024). Furthermore, Memarzadeh and Anand (2020) defined ‘green technologies’ in hotels as eco-friendly systems that are applied to minimize the negative environmental effects in the hotels by achieving efficiency in water, energy, and resource consumption, and waste management. Increasingly, hotel chains are now adopting AI technologies. For example, Accor, a French multinational hospitality company that owns, manages, and franchises hotels in around 110 countries, partnered with three AI startups (Winnow, Orbisk, and Fullsoon) to reduce food waste (Hotel Technology News, 2023). Marriott International has adopted IoT-based LED lighting and smart HVAC systems in its hotels, gaining 15% reduction in energy use (Marriott International, 2023). In addition, several hotels in Sri Lanka installed solar panels and biomass boilers to reduce carbon emissions, energy, and expenses (Periyannan et al., 2023).

Being a major driver of the global economy, the hotel industry now places greater emphasis on sustainable processes and practices because of its extensive consumption of resources and waste generation (Khatter, 2025; Gürlek & Tuna, 2018). In this connection, green hotels play a crucial role in advancing green consumption and environmental protection by implementing sustainable business practices. (Abad & Reyes Jr., 2025). A growing tendency of the hotels has been observed that they are

adopting innovative and eco-friendly technologies as an initiative to enhance sustainability (Periyannan et al., 2023; Ray et al., 2023).

As the technology is evolving rapidly, Industry 4.0 is reshaping how hotels operate, deliver customer service, and implement sustainability practices. In consequence, a wide body of research is emerging at a constant pace while remaining conceptually dispersed and loosely connected (Gunduz Songur et al. 2023). Earlier green technology studies were more focused on environmental practices, eco innovations, considering resource efficiency and competitiveness (Ruiz-Molina et al., 2010; Razumova et al., 2015; Pace, 2016). On the other hand, recent studies are more concerned about adoption drivers, organizational capabilities, smart hotel criteria, and discussed outcomes such as brand equity, stakeholder response, green innovation performance (Mejia, 2019; Dias et al., 2021; Bani-Melhem et al., 2022; Akel & Noyan, 2024; Ray et al., 2023; Lucas et al., 2024; Del Gaudio et al., 2024; Chaudhary et al., 2025b; Wu et al., 2025). Although this evidence indicates that the field is evolving into expanded and advanced knowledge, the literature is still fragmented. In addition, existing review studies focus on themes, content analysis, practices, or bibliometric patterns (Menegaki & Agiomirgianakis, 2018; Gunduz Songur et al., 2023; Khalil et al., 2024; Liu et al., 2024; Yolcu et al., 2025) (see Table 1). they lacks in examining comprehensively. Collectively, these studies map the "what" but inadequately address the "why" (theories) and "how" (causal pathways), resulting in fragmented studies with an incomplete picture of the field landscape. Thus, the growing field of green technology in hotels calls for a comprehensive systematic review.

These shortcomings of previous reviews strengthened the need for a comprehensive review explaining the conceptual structure of the previous studies, combining the analysis of factors crucial for the major antecedent-decision-outcome process. Consequently, this study attempted to address the gaps by addressing the following research questions:

RQ1: How has the intellectual structure of the literature on green technology in hotels evolved?

RQ2. Which theories, contexts, and methods have been applied in the recent literature on green technology in hotels?

RQ3. What are the key antecedents, decisions, and outcomes of green technology adoption, and
how do these antecedents and decisions interact to influence the green technology adoption outcome?
RQ4: What can be theoretically inferred in this research domain and its future research agenda?

Therefore, this study deals with four key goals. First, to answer RQ1, the study will trace the publication frequency by year, identify the most cited articles, and recognize impactful journals. Second, to address RQ2, the study will identify the dominant theories, prevalent methods, and prior research context of green technology research. Third, it will categorize and assess relationships among the antecedents, decisions, and outcomes from the existing literature, addressing RQ3. Finally, based on ADO and TCM, it will discuss the theoretical findings and recommend future research directions, including implications complying with RQ4.

The study presents a significant scholarly contribution by integrating and applying the TCM and ADO framework to present a holistic and causal understanding of green technology research. It synthesizes the dispersed empirical studies and identifies key theoretical and methodological gaps, identifying the road map for future green technology research. In addition, evidence-based recommendations are made for future practical implications.

The rest of the paper is structured as follows. Section 2 describes the method, discussing the search strategy, the PRISMA screening process, and the TCM-ADO framework. Section 3 represents the findings, describing bibliometric patterns, theoretical and methodological trends, and causal relationships. Section 4 outlines the findings, identifies gaps, and proposes future research directions. Section 5 presents theoretical and practical implications. Section 6 illustrates the limitations and the conclusion.

Table 1: List of Review Articles

Author and Year	Aim of the Review	Implementation of SLR Framework	Database(s) Employed for Article Selection	No. of Articles Considered	Time Frame	Contribution of the Study
Gunduz Songur et al. (2023)	To explore green technology development in hotels via a literature review and bibliometric analysis.	Yes, the study applies an SLR approach, specifically a four-stage literature review approach.	• EBSCOhost's Hospitality and Tourism Complete • ABI/INFORM Collection (ProQuest) • Web of Science • Scopus • Emerald Management eJournals	64 articles	1999 to 2020	• Categorizes articles into clusters: sustainability, eco-friendly practices, and green technology adoption. • Identifies seven emerging themes.
Yolcu et al., (2025)	To analyze technology's role in hotel competitiveness using bibliometric/cluster analysis.	Yes	Scopus; Web of Science	537	1982-2024	• Identified six thematic clusters; • Demonstrated tech's impact on competitiveness • Provided strategic framework for digital transformation; • Highlighted AI/IoT/sustainability synergies;
Khalil et al., (2024)	To review stakeholder perspectives on green practices and their impact on sustainable hotel performance.	Yes	Emerald, Elsevier, Taylor and Francis	57	January 2012 - December 2021	-Identified 27 green practice attributes across stakeholders. -Aligned them with sustainability pillars. -Developed a framework linking green practices to hotel performance. -Highlighted implementation challenges and stakeholder insights.
Liu et al., (2024)	To explore the depth of scholarly articles related to smart	No	Web of Science (WoS)	613	Inception to August 26, 2023	-Identifies research gaps in smart hotels (theory integration, consumer green decisions).

	hotels using a bibliometric technique.					-Proposes a framework for customer decisions considering tech advances.
Menegaki, & Agiomirgianakis (2018)	To compile fragmented knowledge on sustainable hotel technologies in Greek hotels.	No	Various sources (reports, publications, institutional records, web resources)	N/A	Not specified (qualitative review of practices)	- Provides a benchmark for Greek hoteliers to adopt sustainable practices; - Documents energy/water conservation, waste management, and food sustainability strategies.

Source: Author's analysis

2. Method

2.1. Systematic Literature Review Protocol

The current study employed bibliometric analysis and systematic literature review (SLR) to investigate green technology adoption in hotels. Bibliographic analysis helps profile the prior studies through graphs and quantitative data (Pritchard, 1969), while SLR further explores content synthesis for coding and categorizing data (Tranfield, 2003). This study employed a structured systematic literature review guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework (Moher et al., 2009; Page et al., 2021). The process of the systematic review (PRISMA) reflected in the study is replicable, scientific, and transparent (Tranfield et al, 2003; Moher et al., 2009) and adopted in recent sustainability reviews (Costa et al., 2020; Oliveira Neto et al., 2023a; Oliveira Neto et al., 2023b). Screening and coding were performed by two researchers independently so that bias remains minimized (Hayes & Krippendorff, 2007). As suggested by Costa et al (2020), exclusion and eligibility criteria were maintained in line with PRISMA guidelines. **As the study is a systematic literature review, the clinical trial number is not applicable.**

To ensure methodological rigor, the study followed a four-phase (identification, screening, eligibility, and inclusion) PRISMA framework. (Page et al., 2021). These four phases could

be categorized as data collection and data screening stages, and further complemented by data analysis stages as proposed by Aryee (2024) and Aryee (2025).

2.2. Data collection

Phase 1 (Identification) initially identified literature from two widely accepted databases, Scopus (containing 132 articles) and Web of Science (91 articles). Scopus and Web of Science databases were used because they are considered the most comprehensive and reliable collections for sustainability research (Sánchez et al, 2017; Haq et al., 2026). Search strings combined technology terms with sector-specific terms to identify the peer-reviewed studies from 2010 to 2025. The search ended in December, 2025. Mentioning a clear cut-off date is essential for replicability as suggested by Thomé et al. (2016). The search strings are shown below in Table 2.

Table 2: Search string used for database search

Database	Search String used
Scopus	TITLE-ABS-KEY ((“green technolog*" OR "eco-friendly technolog*" OR "sustainable technolog*" OR "clean tech*" OR "environmental innovation*”) AND (“hotel*" OR "hospitality industry" OR "lodging" OR "resort*" OR "accommodation sector”))
Web of Science	TS = (“green technolog*" OR "eco-friendly technolog*" OR "sustainable technolog*" OR "clean tech*" OR "environmental innovation*”) AND (“hotel*" OR "hospitality industry" OR "lodging" OR "resort*" OR "accommodation sector”)

2.3. Data Screening

In Phase 2 (Screening), articles are reviewed against some basic screening criteria. The database screened and excluded non-peer-reviewed journal articles and non-English language articles. Further, the remaining database was restricted to subject areas such as business, management, social sciences, economics, and engineering. Excluded articles from the subject areas include physics and astronomy, Mathematics, Medicine, chemical engineering, immunology, etc., that are purely technical or do not have technology adoption and organizational (hotel) focus. Thus, 105 articles were removed from both databases. To ensure methodological transparency, inclusion and exclusion criteria are presented in Table 3.

Table 3: Inclusion and exclusion criteria

Criterion	Inclusion	Exclusion
Article type	Peer-reviewed journal articles	Books, book chapters, conference proceedings, dissertations
Language	English	Other languages
Time frame	2010 – 2025	Before 2010
Subject area	Business, management, hospitality, sustainability, environmental science with adoption focus	Pure engineering, technical only, no link to hotels
Relevance	Directly addresses green technology adoption in hotels	No clear link to green technology or hotels

Phase 3 (Eligibility) was completed by the full-text review of the articles retained after phase 2. Using R (further verified manually in Excel), we excluded the duplicate entries (n=31) from Scopus and WoS. Next, full-text articles were scrutinized and assessed for study scope and relevance. 25 articles were excluded for non-compliance with the study scope, resulting in 62 articles considered for final analysis.

In Phase 4 (Inclusion), final articles were coded and data extracted in accordance with the frameworks. The complete four-phase protocol is illustrated in Fig. 1.

2.4. Data analysis: The authors, titles, and objectives of the articles, source titles, Years of Study, applied theories, Methods, Locations of the study, industry contexts, key findings, research gap, abstracts, keywords, and publishers were used for data extraction.

Two authors separately and independently screened articles' titles, abstracts, and full-texts. Cohen's Kappa was used for ensuring inter-rater reliability as suggested by Hayes & Krippendorff (2007) and Thomé et al. (2016) considering 20% sample standard (13 articles). The value of Cohen's Kappa was $\kappa = 0.87$. The disagreements were addressed

by mostly discussion or by a third author. After the final selection the Snowball technique was applied to the references of the 62 articles following Thomé et al. (2016), resulting no additional articles included. This indicates search saturation.

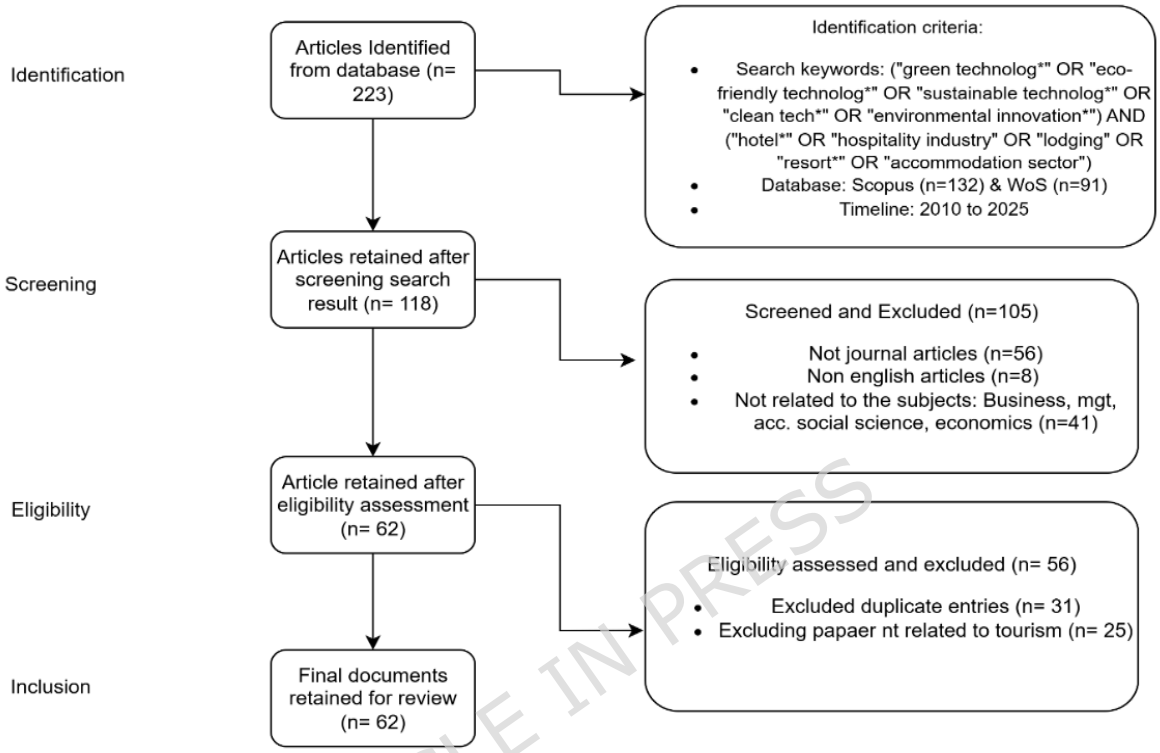

Fig. 1: PRISMA Flowchart for study selection process

2.5. TCM-ADO Integration:

This study is designed around two complementary frameworks, TCM and ADO (Lim et al., 2021; Paul et al., 2017; Paul & Singh, 2017; Mishra & Kiran, 2024; Prasanna et al., 2025). TCM (Theories, Context, and Methods) observes theoretical foundations, contextual settings, and methodological approaches in prior studies (Paul et al., 2017). ADO (Antecedents, Decisions, and Outcomes) maps the causal pathways affecting green technology adoption and deals with the discovery of the ‘black box’ of green technology drivers' interaction mechanism (Paul & Benito, 2018). According to Lim et al. (2021), the integrated TCM-ADO framework integrates macro-level landscape with micro-level adoption dynamics, providing a holistic insight into ‘what do we know’ and ‘how do we

know'. In addition, this dual framework overcomes the weakness of each standalone framework and creates a 'synergy' effect (Mishra & Kiran, 2024). Furthermore, the TCM-ADO framework creates a bridge between theory and operational variables, providing theory-backed actionable insights and implications for managers and stakeholders (Kumar & Kushwaha, 2025). Finally, the dual framework explores and connects understudied theories and variables and vice versa, and is able to propose a more complete, insightful research gap for future direction (Paul et al., 2017; Mishra & Kiran, 2024; Prasanna et al., 2025).

2.6. Rationale for not performing cluster analysis

The current study did not conduct cluster analysis (co-citation or keyword cluster analysis) because our research objective was causal mapping employing ADO complemented by TCM analysis, not thematic grouping. However, we acknowledge that, as suggested by Oliveira Neto et al. (2025), the cluster analysis could complement the TCM-ADO study analysis. This limitation is mentioned in section 6.1.

3. Analysis and Findings

3.1. Bibliometric Evolution of the Field

This section analyzes the impact of publications through citation patterns and journal productivity in green hotel technology research.

3.1.1 Publication frequency

The scientific value and impact of research are identified by prestigious journals in which the research emerges. International journal rankings can be categorized into four distinct types: Q1, Q2, Q3, and Q4. Q1 denotes the highest scientific value based on the Scimago journal rank. Fig. 2 shows the total number of articles published on green technology in our sample based on journal rankings between 2010 and 2025. Most of the articles (39 out of 62), 62.90%, are published in Q1-ranked journals. The number of studies has increased significantly in the last three years, showing that the significance of this topic in the research domain has increased in recent years.

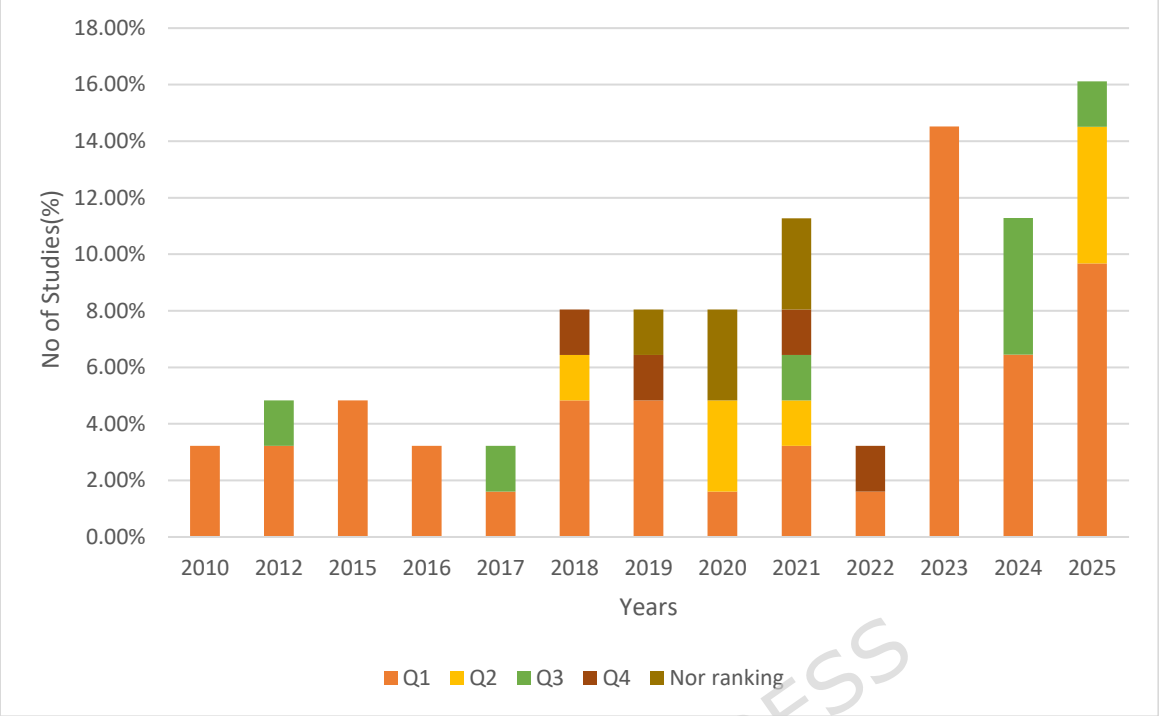

Fig. 2: Distribution of studies by Journal ranking (n=62) (Source: Authors' analysis).

3.1.2. Most Cited Articles

Among the selected articles, the ten most influential articles (Table 3) collectively generated 982 citations, underscoring their significant impact. The study of Gürlek and Tuna (2018) had the highest citations, 265, with the highest citation per year. Articles of Weaver (2012) and Zhang et al. (2018) had received total citations of 167 and 111, respectively. Some of the recent studies (Elzek 2021; Bamidele et al. 2023) received considerable attention and impact in recent studies, indicating rising scholarly interest in green technology.

Table 3: Top ten articles based on citations

Rank	Author	Total citations	Rank (by citation per year)	Author	Citation Per year
1	(Gürlek & Tuna, 2018)	265	1	(Gürlek & Tuna, 2018)	37.85
2	(Weaver, 2012)	167	2	(Zhang et al., 2018)	15.85
3	(Zhang et al., 2018)	111	3	(Gomez-Conde et al., 2019)	15.67

4	(Gomez-Conde et al., 2019)	94	4	(Weaver, 2012)	12.84
5	(Pace, 2016)	81	5	(Pace, 2016)	9
6	(Razumova et al., 2016)	49	6	(Elzek et al., 2021)	8.75
7	(Mejia, 2019)	49	7	(Mejia, 2019)	8.16
8	(Fizaine, 2013)	46	8	(Bamidele et al., 2023)	8
9	(Elzek et al., 2021)	35	9	(Bani-Melhem et al., 2022)	7.75
10	(Tugores & García, 2015)	31	10	(Ray et al., 2023)	5

Source: Author's own analysis

3.1.3 Most Productive Journals

The Journal of Sustainable Tourism and Sustainability is the most impactful journal considering the highest publication frequency, as shown in Fig. 3. Hospitality-centric journals such as the Journal of Hospitality Marketing & Management and the Journal of Hospitality and Tourism Insights contribute to promoting green technology adoption studies and bridging theoretical and applied perspectives. Broader scope journals such as the Science of the Total Environment appear to prioritize less on green technology ideas; however, their presence indicates an interdisciplinary nature of green technology research. The representation of the social science journal in Fig. 3 is aligned with our inclusion criteria because we retained documents or articles from business, management, social sciences, and economics subject areas, but excluded purely technical articles.

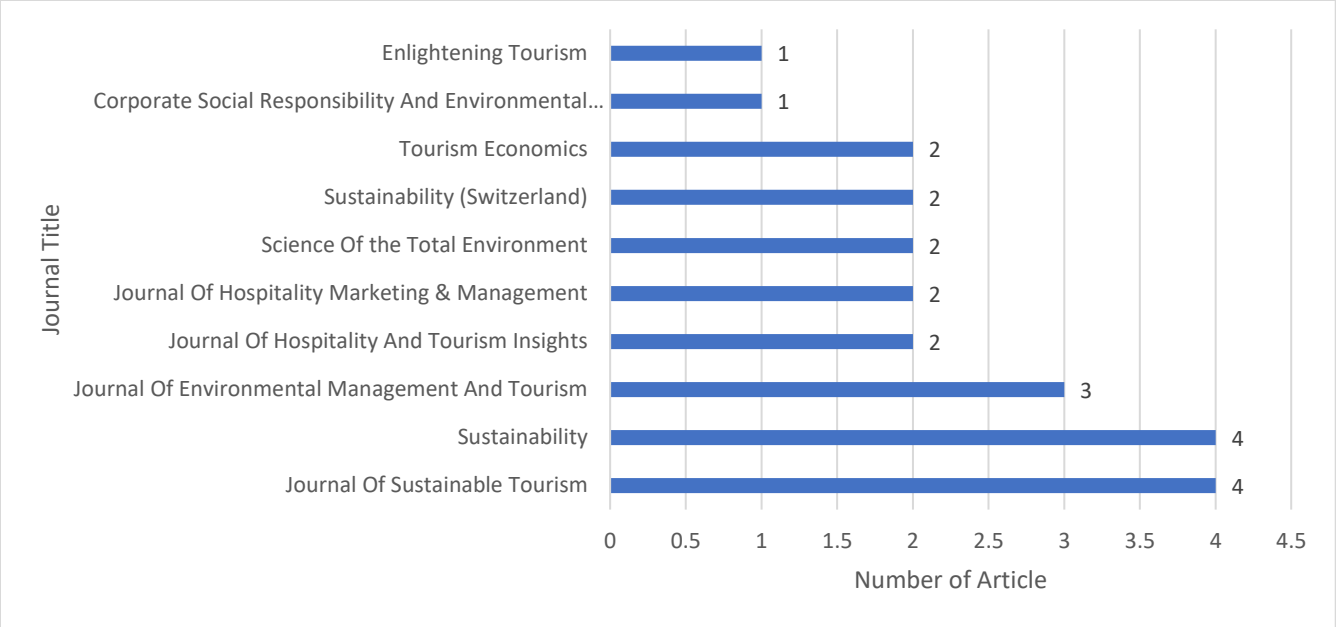

Fig. 3: Top ten Journals based on frequency of publications (Source: Author's analysis)

3.1.4. Distribution of articles based on discipline

Further, the study classified the reviewed 62 articles on the basis of their primary discipline, demonstrating the interdisciplinary nature of green technology research. Table 4 shows the distribution of the articles. Reviewed articles predominantly represent multiple disciplines including Hospitality & Tourism Management (53.22%) and Business Management / Strategy (16.13%) indicating largest share. Presence of fields such as business, economics, and engineering indicate that green technology research involves organizational, economic, and technical focus.

Table 4: Discipline wise distribution of articles

Discipline	Frequency	Percentage (%)
Hospitality & Tourism Management	33	53.22%
Business Management / Strategy	10	16.13%
Environmental Sustainability / Science	6	9.68%
Economics / Innovation Economics	6	9.68%
Engineering / Technology Management	4	6.45%
Other (Sociology, Geography, etc.)	3	4.84%
Total	62	100%

Source: Author's own estimation

3.2. Content Analysis Based on the TCM Framework

The section explains the theoretical foundation, contextual setting, and methodological pattern of reviewed articles based on the widely accepted TCM framework. (Mishra & Kiran, 2024; Prasanna et al., 2025).

3.2.1 Theoretical Foundations (T)

Theories explain the foundational base of empirical studies by discussing the "why" and "how" behind the adoption of green technologies (Gürlek & Tuna, 2018). Following the approach of Aryee (2024), we structured this section. The study analysis found 34 distinct theories applied in prior literature that could be categorized into six categorical clusters (Table 4).

Behavioral & Psychological Theories were used frequently to examine the psychological drivers affecting green technology adoptions, considering hotel guests or employees. The theory of planned behavior (Ajzen, 1991) was employed most frequently, appearing in seven articles, to explain individuals' intention to perform a technology-centric behavior in hotels. Other notable theories include Value-Belief-Norm (VBN) Theory (Stern, 2000), Social Cognitive Theory (Bandura, 1986), Cognitive Appraisal (Lazarus, 1991), and Affective Events Theory (Weiss & Cropanzano, 1996). VBN theory highlights moral motivation of behavior through value, beliefs, and norms, whereas social cognitive theory emphasizes learning and self-efficacy, and Cognitive Appraisal Theory explains how emotions are created.

Strategic and organizational theories, in the context, explained how hotels utilize their resources to gain a competitive advantage through sustainable practices. Resource-Based View theory (Barney, 1991), the dominant theory, appearing in seven articles (Bani-Melhem et al., 2022; Neupane et al., 2025), emphasizes internal resources and capabilities to achieve organizational success. Dynamic Capabilities Theory (Teece, 2007) and Stakeholder Theory (Freeman, 2010; Freeman & Phillips, 2002), mentioned in four articles (for example, Dias et al., 2021), are often complemented by the RBV

theory. Dynamic Capabilities Theory emphasizes the transformation of resources, whereas Stakeholder Theory underscores the need for stakeholder relationship optimization. Other notable theories in the categories are shown in Table 4.

Sustainability and Environmental Theories create the foundation of the green technology research that prioritizes environmental protection, ecological balance, and innovation. In this category, sustainability theory (Elkington & Rowlands, 1999) is cited the most (six mentions), with Eco-Innovation Theory (Rennings, 2000) cited in five articles (Marquez et al., 2023). In addition, Sustainable Development Theory (WCED, 1987) emphasizes environmental, social, and economic sustainability, and Sustainable Tourism Theory (Bramwell & Lane, 1993) highlights tourism development through protecting natural and cultural resources and benefiting local communities.

Technology Adoption & Diffusion theories that include the widely applied Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) theory, which explains the user technology acceptance process with the core four determinants, and Technology Acceptance Model (TAM) (Davis, 1989), which emphasizes perceived usefulness and ease of use. Transformational Leadership theories (Bass, 1985) and Economic & Analytical theories such as Evolutionary Game Theory (Smith, 1982) have caught the attention of researchers. The theories are discussed in Table 5.

Table 5: Theories applied in the studies

Category	Featured Theories in Category	Featured Articles
Behavioral & Psychological	Theory of Planned Behavior (TPB) 7 mentions, Value-Belief-Norm (VBN) Theory, Rational Choice Theory, Social Cognitive Theory, Cognitive Appraisal and Affective Events Theories, Construal Level Theory (CLT), Nudge Theory	Clark et al. (2025); Bani-Melhem et al. (2022); Filimonau et al. (2024)
Strategic & Organizational	Resource-Based View (RBV) 7 articles mention, Dynamic Capabilities Theory and Stakeholder Theory both 4 mentions, Natural Resource-Based View (NRBV), Absorptive Capacity Theory, Network Relationship/Social Capital Theory, Strategic Fit Theory, Innovation and Competitive Advantage Theory, Management Accounting and Control Systems (MACS) Theory, Brand	Chaudhary et al. (2025b); Neupane et al. (2025); Sharma et al. (2024); Fores (2019)

	Alliance Theory, and the Grounded Theory Approach.	
Sustainability & Environmental	Sustainability Theory with 6 mentions, Eco-Innovation Theory with 5 mentions, Sustainable Development Theory and Sustainable Tourism Theory each 3 mentions, the Environmental Kuznets Curve (EKC) Theory, Pollution Prevention Theory, Tourism Area Life Cycle Theory, and Environmental Management Systems (EMS) Theory.	Abad & Rayes (2025); Elzek et al. (2021); Menegaki (2018)
Technology Adoption & Diffusion	Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT), Diffusion of Innovations Theory:	Razumova et al. (2015). Mejia (2019)
Transformational & Leadership	Transformational Leadership Theory, Business Transformation Theory, Digital Transformation Theory	Filimonau et al. (2024)
Economic & Analytical	Transaction-Cost Economics Theory, Evolutionary Game Theory	Gu (2023); Sun et al. (2021)

3.2.2 Contextual Settings (C):

Contextual coverage analysis is crucial to analyze a field of research because it defines the boundary of the field's knowledge, improves relevance, and enhances validity.

Geographical coverage is the primary consideration for recognizing the field concentration. Analysis of study locations (Table 6) indicates that most of the studies were conducted in developed economies (68% of the studies). Among them, the USA, Spain, and the UK are leading in the field, which might be attributed to the stricter environmental regulations and guest consciousness (Razumova et al., 2015). In contrast, emerging economies (India, China, Brazil) are represented in fewer studies, accounting for only 32% of the studies. Similarly, Sub-Saharan Africa study representations are limited, and only one study was found in the context of Nigeria. Cross-national comparative studies are lacking in number, amounting to only 10% of the studies.

Table 6: Contextual Coverage

Countries	No. of Articles	Countries (contd.)	No. of Articles
China	3	New Zealand	1
United States	5	Portugal	1
India	5	Russia	2
Spain	5	Sri Lanka	1
Multiple countries	6	Turkey	1
Brazil	2	United Arab Emirates	1
Egypt	2	United Kingdom	1
Greece	2	Dominican Republic	1
Mexico	2	Indonesia	1
Nepal	2	Lebanon	1
Philippines	2	Malta	1
Poland	1	Nigeria	1
Peru	1	No specific country	8
South Korea	1	Total	62
Vietnam	1		

Sectoral Focus:

The reviewed articles reveal that distinct concentrations of research on the hospitality industry. As Fig. 4 explains, the majority of the studies (40%) mentioned the general hotel industry without mentioning a specific category of hotel (type, size, or rating). This indicates the tendency of the prior literature in industry-wide trends concerning green technology. A significant number of studies (30%) specifically considered luxury or star-rated hotels. This indicates that star-rated hotels are more emphasizing green technology than non-rated hotels, or guests of rated hotels are more concerned about the sustainability practices of hotels (Chaudhary et al., 2025a). 30% of studies examined SMEs or family-run hotels, signifying the development of this category of hotels that have resource constraints but strive for strategic sustainability (Neupane et al., 2025). Studies combining the hotel industry and other industries, such as aviation (Lim et al., 2012) and other industries (Weaver, 2012), are not uncommon. Several niche hotel segments are

also considered in emerging studies, such as hotel chains (6%) and Integrated Hospitality (HORECA). The smallest category consists of researchers analyzing the integrated Hotel-Restaurant-Café/Catering (HORECA) segments, signifying diversity in green technology adoption.

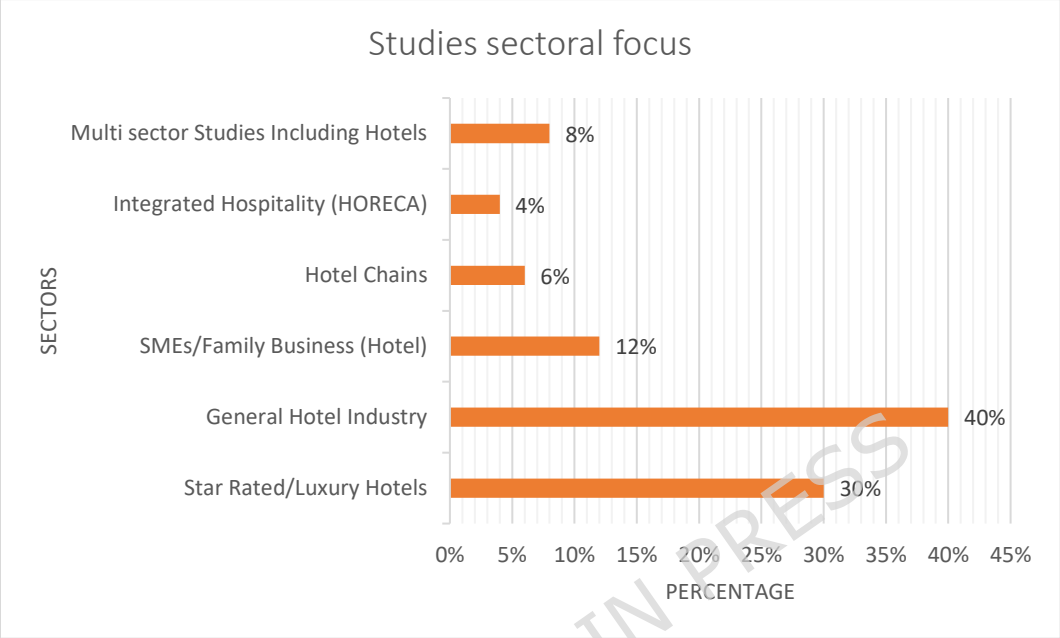

Fig. 4: Publications by sector (Source: Authors' analysis)

3.2.3 Methodological Approaches (M) in the reviewed studies

The methodological analysis of the reviewed articles revealed that the field has a strong orientation towards empirical approaches. The study further advances layered understanding by illustrating a broad research design (Fig. 5) and specific analytical methods (Table 6).

The broad research design explains the predominance (51.61 %) of the quantitative research, as the field is primarily concerned with measuring complex relationships with structural hypothesis testing through modeling (Chaudhary et al., 2025a, 2025b, 2025d; Dias et al., 2021). These studies deal with measuring guests' or stakeholders' intentions, attitudes, and behavioral patterns relating to technology adoptions. To explore the complex phenomena and understand stakeholders' narratives, the quantitative approach is complemented by qualitative (11.29%) and mixed-method studies (11.29%). Qualitative

and mixed methods explore phenomena that are not accessible by a quantitative survey only. Conceptual studies (12.90 %) indicate critical conceptual analysis of present knowledge and projecting future research directions.

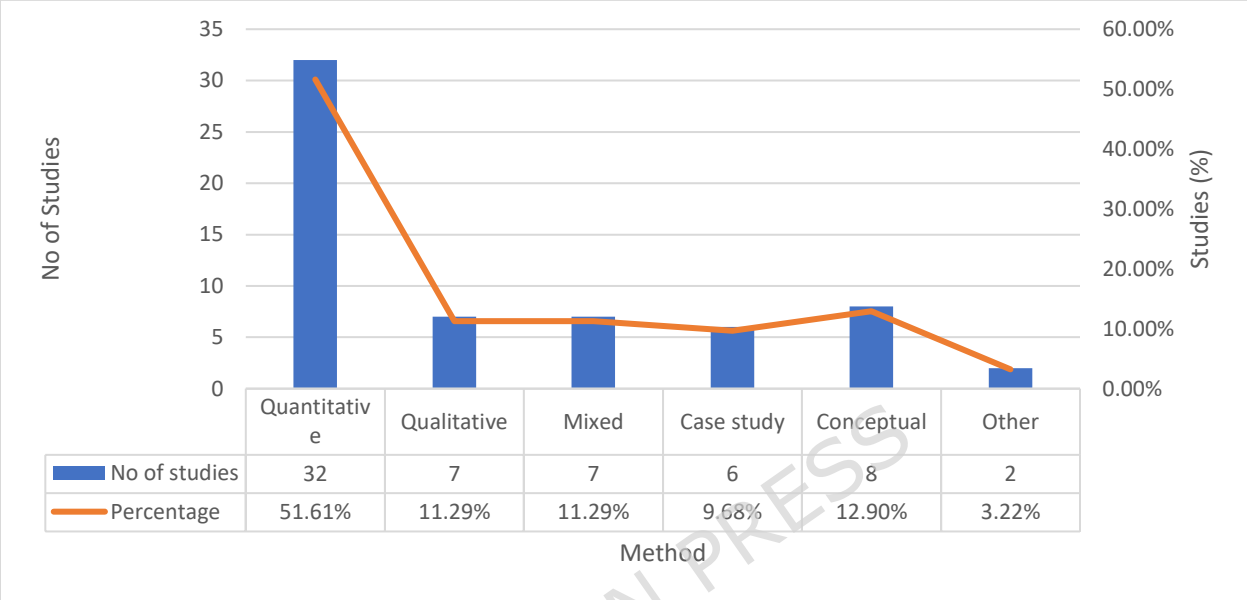

Fig. 5: Method analysis and distribution (Author analysis)

Table 7 further explains the detailed methodological approaches applied in the prior studies within the broad designs discussed in fig. 5. Among all the studies, 27.9% of them employed Structural Equation Modeling, which not only explains quantitative dominance but also signifies the field's growth in analysis and validating causal theories. The significant share of Thematic analysis (18.0%) and case study methodologies (8.2%), which are a substantial share of qualitative and mixed method studies, indicates the in-depth exploration of contextual, theoretical, and stakeholder-specific dimensions of prior research. Moreover, advanced analytical techniques such as social network analysis, fsQCA, and panel data regression specify the increasing methodological sophistication. These specific investigations complex, configurational, and longitudinal questions in the context of green technology adoption and indicate the evolving maturity in the literature.

Table 7: Methods structure adopted by reviewed studies

Analytical Approach	Specific Methods	Percentages of studies employed	Representative Articles
Causal & Path Modeling	Structural Equation Modeling (SEM/PLS-SEM)	27.9%	Chaudhary et al., 2025a; Filimonau et al., 2024; Neupane et al. 2025
	Hierarchical Linear Modeling (HLM)	1.6%	Bani-Melhem et al. 2022
Regression & Econometrics	Regression Analysis	9.8%	Wu et al., 2025; Nathaniel et al., 2023
	Logit Regression	1.6%	Razumova et al. 2015
	Probit Regression	3.3%	Razumova et al., 2016; Tugores & Garcia, 2015
	Panel Data Regression	3.3%	Ali et al., 2023; Nathaniel et al., 2023
	DID/PSM	1.6%	Qian & Zhang, 2023
	OLS Regression	3.3%	Gomez-Conde et al., 2019; Lim et al., 2012
Qualitative Exploration	Thematic Analysis	18.0 %	Clark et al., 2025; Sharma et al., 2024; Mejia, 2019
	Content Analysis	4.9%	Gunduz Songur et al. 2023
	Narrative Analysis	1.6%	Malacapay & Tababa 2020
	Case Study	8.2%	Malacapay & Tababa, 2020; Wijayanti et al., 2021
	Cross-case Analysis	1.6%	Wijayanti et al., 2021
Advanced Analytics	fsQCA	1.6%	Chaudhary et al. 2025b
	ERGM/Social Network Analysis	1.6%	Sun et al. 2021
	Cluster Analysis	1.6%	Pérez-Pineda et al., 2017
Descriptive & Basic Stats	Descriptive Statistics	3.3%	Abad & Reyes, 2025; Menegaki 2018
	ANOVA	1.6%	Kotsia et al., 2020
	Index Development	1.6%	Amazonas et al., 2018
	Trend Analysis	1.6%	Troyanskaya et al., 2021

3.3. ADO Framework-Based Analysis

The ADO framework enables a comprehensive understanding of the literature, measuring both its depth and breadth while identifying the evolution of the knowledge (Paul & Benito, 2018; Paul et al., 2024). The ADO framework identifies the antecedents, decisions, and outcomes embedded in the literature (Lim et al., 2021; Paul & Benito, 2018). In line with the framework structure, it could critically analyze the literature and its constructs to identify drivers (Antecedents) influencing green technology adoptions, resulting in strategic choices the hotel makes (Decisions), and consequences or end result.

The voting method has been applied in the study following Kahiya's (2018) guidelines to trace the connections among the Antecedents, decisions, and outcomes (Table 8). The authors initially identified the connections among the literatures and reached a consensus about five categories of antecedents, three categories of decisions, and three categories of outcomes following the procedures of Kahiya (2018). Drawing on 198 connections, the table depicted connections as intersections of columns and rows and presented positive, negative, and insignificant relationships.

Table 8: ADO Framework Relationship Map

	Decisions									**Outcomes**											
Antecedents	**Green Tech Adoption**			**Sustainable Process Innovation**			**Eco-Service Transformation**			**Environmental Performance**			**Economic Performance**			**Stakeholder Value**			**Total**		
	+	0	-	+	0	-	+	0	-	+	0	-	+	0	-	+	0	-	+	0	-
Technological Factors	17	4		3			2	1		13	1		6	2		8	1		41	9	0
Environmental Drivers	6			7	1		1			21			8	1		10			43	2	0
Organizational Resources	21	3	2	13		2	7		1	15		4	19	8	1	12	2	1	75	13	11
Market & Consumer Pressures	12	2	1	1			6	3		10			8	4	2	12	4		37	13	3
Barrier Factors	1		9							1	1	4			5		1		2	2	18
Total	**57**	**9**	**12**	**24**	**1**	**2**	**16**	**4**	**1**	**60**	**2**	**8**	**41**	**15**	**8**	**42**	**8**	**1**	**198**	**39**	**32**

Note: This table maps the links. The symbols indicate the nature of the relationship: (+) indicates positive connections, (0) indicates Insignificant connections, and (-) indicates negative connections. The numerical values show the frequency of links found in studies. ***(Source: Author's own analysis).***

3.3.1 Antecedents

The green technology adoption process begins with a stimulation or driver that is termed an antecedent. The capacity, willingness, and readiness of hotels are determined by the antecedents, which can be classified into five categories.

Major technological Factors identified from the reviewed articles are energy-efficient technologies, ICT integration, water-saving technologies, and renewable energy systems (Menegaki, 2018; Razumova et al., 2015; Periyannan et al., 2023). These factors act as a precondition for organizational decisions and the ultimate adoption of green technologies (Razumova et al., 2015; Menegaki, 2018). For example, Menegaki (2018) discussed in Greek accommodations how solar water heater, LED lighting, and HVAC systems, like technological drivers, reduce cost and expedite the adoption of green technologies.

Similarly, studies observed several **Environmental Drivers that** showed the strongest positive association considering environmental performance outcomes (Nathaniel et al., 2023; Ali et al., 2023). Government regulations, evolving policies, environmental crises, consumer consciousness, and regulatory pressures are identified as dominant antecedents (Martínez-Rubio et al., 2024; Gu, 2023; Razumova et al., 2015). For example, Martínez-Rubio et al. (2024) identified Environmental culture and Environmental consumption as strong motivations to achieve environmental sustainability in the context of Mexican hotels. Similarly, China's hospitality industry confirmed that environmental regulation positively influences green innovation (Gu, 2023).

Organizational Resources-based Antecedents are the most influential drivers as they constitute the most connections (75 connections) compared to other antecedents, revealing their critical role in sustainable technology adoption (Bani-Melhem et al., 2022; Del Gaudio et al., 2024; Gürlek & Tuna, 2018). In these categories, influential identified drivers are hotel size, corporate environmental ethics, stakeholder demand, market pressure, market demand, and human capital pressure (Sharma et al., 2024; Bani-Melhem et al., 2022; Del Gaudio et al., 2024; Lucas et al., 2024). Martínez-Rubio et al. (2024) found that technological capacity positively influences environmental innovation and advances technology adoption in Mexico. Lucas et al. (2024), while assessing

sustainability practice across Asia and Africa, found that combined technological, organizational, and environmental drivers influence technological sustainability and adoption.

Market & Consumer Pressures, another dominant driver category, includes customer perception of green practices, guest or visitor requirements, and guests/customers' demand for eco-friendly products (Ray et al., 2023; Amazonas et al., 2018). For instance, Brazilian hotels, particularly in João Pessoa, are favoring green technologies because their guests prefer to stay in that kind of hotel and are willing to pay a premium for experiencing sustainable technologies (Amazonas et al., 2018).

Barrier Factors are considered as negative drives that restrict eco-technology adoption (Marquez et al., 2023; Razumova et al., 2016; Ray et al., 2023). These are identified as high Upfront Costs, Regulatory complexity, Lack of Awareness of guests, Financial Viability Concerns, and Misperceptions by guests or customers. While exploring Hotel of Peru, Marquez et al. (2023) found that High investment costs and the dearth of suppliers in distant places restrict the adoption of eco-friendly technologies.

3.3.2 Decisions

Decisions represent the interim strategic choice of hotels influenced by antecedents that might have a direct impact on technology adoption outcomes (Paul & Benito, 2018). Decision constructs could be categorized further into three distinct variables.

The green technology adoption category shows the most positive and the strongest connections with sustainable outcomes (Periyannan et al., 2023; Legendre et al., 2024). This decision includes adopting energy-efficient technologies, a renewable energy system, water-saving technologies, waste management practices, and ICT integration (Periyannan et al., 2023; Legendre et al., 2024; Khatter, 2025). For example, Periyannan et al. (2023) confirmed that in Sri Lanka, hotels adopting biomass boilers, solar PV installation decisions, and energy-efficient chillers successfully reduced the cost and ensured financial returns. Similarly, Legendre et al. (2024) identified that AI-supported food waste management was successful in quantifying the waste and reducing costs.

Sustainable process innovation is the further advancement in implementing technology adoption through the operationalization of the technology concepts (Gomez-Conde et al., 2019; Fores, 2019). Green technology delivers infrastructure, whereas sustainable process innovation integrates the concept into the daily operations (Frishammar et al., 2012). Process innovation includes operationalizing waste reduction processes, recycling, optimizing water management systems, launching systems to save energy, or sourcing sustainably (Elzek et al., 2021; Bani-Melhem et al., 2022; Gomez-Conde et al., 2019). For example, Gomez-Conde et al. (2019) validated that management and operational accounting and departmental control systems support sustainable practices. Literature suggests that technology is not sufficient on its own; process innovation drives the technology to maximize organizational benefit **(**Dias et al., 2021).

Eco-Service Transformation outlines hotels' strategic moves in which they define guest services and experiences through the lens of sustainability (Chaudhary et al., 2025a; Chaudhary et al., 2025d**)**. It shifts green practices from internal operation to a visible value proposition. This transformation includes eco-certifications of services, and labeling of sustainable services, actively involving visitors in green practices, and integrating and communicating sustainability in marketing and promotions (Akel & Noyan, 2024; Ray et al., 2023). Customer-centric outcomes are more visible in studies that showed hotels' adoption of green technology influences guests' satisfaction and safety (Chaudhary et al., 2025a).

3.3.3 Outcomes

Measurable outcomes stem from the decision factors or direct influence from antecedents (Paul & Benito, 2018). Three dimensions are identified as follows,

Environmental Performance is the most dominant outcome produced from major environmental drivers and organizational resources, and that includes energy consumption reduction, water usage reduction, reduction of waste and carbon emission, and overall resource efficiency (Menegaki, 2018; Periyannan et al., 2023; Nathaniel et al., 2023). Sixty positive connections were recognized in the reviewed literature, emphasizing

the benefits in hotels. For example, a Greek hotel observed energy and water conservation efficiency through solar heating (Menegaki, 2018), and Sri Lankan hotels achieved considerable efficiency in controlling emissions through biomass boilers and chillers (Periyannan et al., 2023)

Economic Performance outcomes encompass return on investment, cost savings, and revenue growth from sustainable procedures, or increased shareholder value (Gu, 2023; Qian & Zhang, 2023; Elzek et al., 2021). Studies demonstrated that in China, hotels generated a considerable amount of revenue through green innovation (Gu, 2023). Similarly, in particular segments, installing Tesla EV charging stations resulted in increased hotel revenues (Qian & Zhang, 2023). However, economic performance is measurable but not always predictable. For example, for some outcomes achieved in the short term, while some others, such as ROI, could be achieved in the long term, and initially, it remains negative (Ray et al., 2023).

Stakeholder Value, which is another significant outcome, could be identified as brand image, customer loyalty, investor confidence, employee engagement, local and international approval and recognition, or community perceptions (Chaudhary et al., 2025b; Bani-Melhem et al., 2022; Sharma et al., 2024). This value outcome is simultaneously influenced by organizational resources, market and consumer pressure, and environmental drivers (Del Gaudio et al., 2024; Amazonas et al., 2018). A considerable number of studies confirmed that green technology enhances guests' satisfaction, safety, and customer loyalty (Chaudhary et al., 2025a; Chaudhary et al., 2025d; Bani-Melhem et al., 2022)

The integrated TCM-ADO framework is demonstrated in Fig. 6.

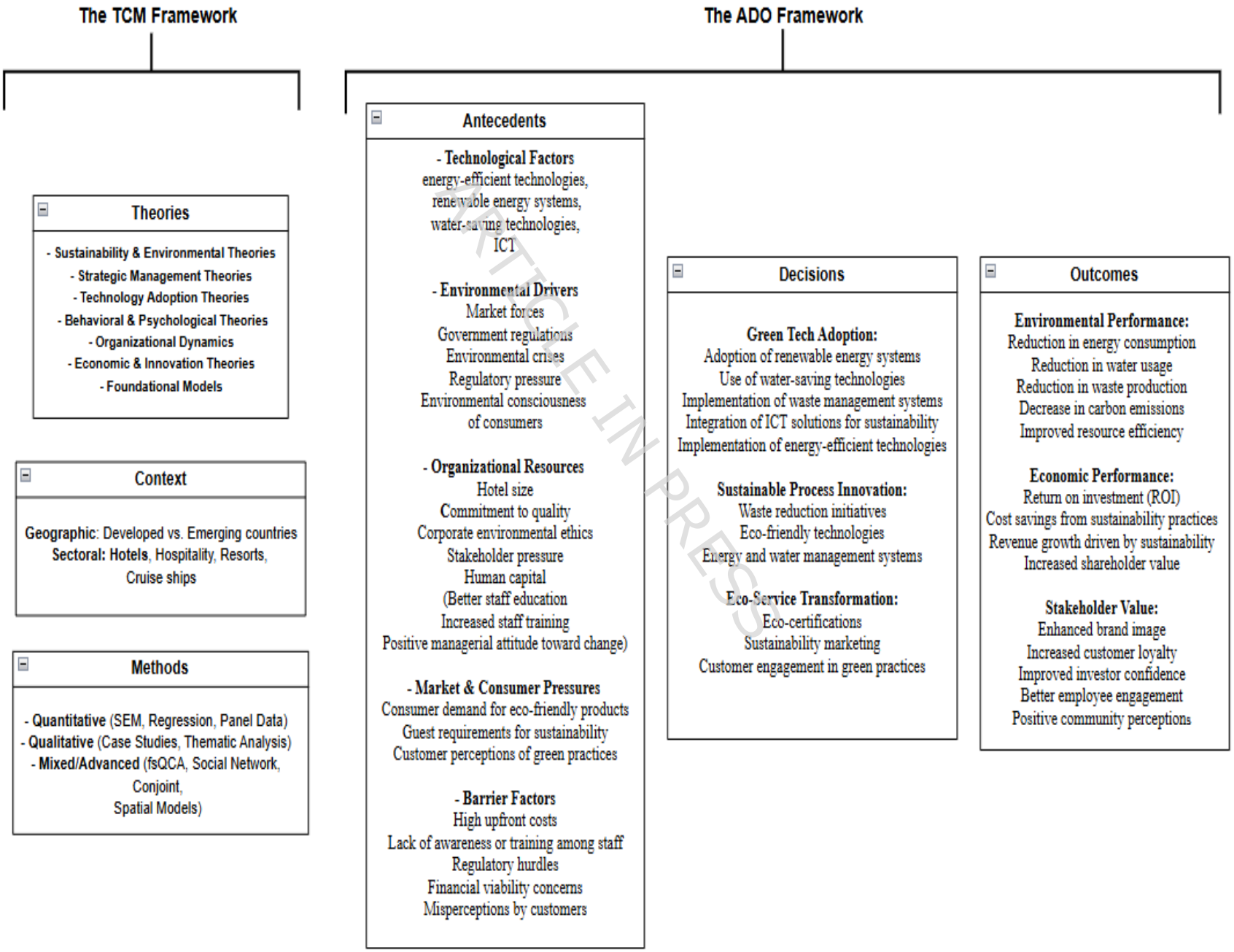

Fig. 6: Integrated TCM-ADO Framework for Green Technology Adoption in Hotels

4. Discussion and Future Research Directions

4.1. Discussion

The study analyzed 62 key articles studying green technology and its relevant constructs to map the critical findings within the TCM-ADO framework. This section addresses the critical findings and discusses possible explanations.

First, drawing on the TCM framework, analysis of theories (Table 4) reveals that the employed theories across studies are **fragmented and dispersed**. In studies, different theories were adopted, but in most cases, they are applied separately, which creates scattered knowledge and fragmented understanding (Gunduz Songur et al., 2023; Khalil et al., 2024). The phenomenon could be attributed to the nature of the study subject, 'Green technology adoption' (see Table 5). For Example, individual behavior theories (such as the Theory of Planned Behavior) are different and rarely applied with theories about organizational strategy (such as the Resource-Based View) (Clark et al., 2025; Chaudhary et al., 2025b). As adopting green technology requires both individual and organizational decisions, the lack of integrated theories or frameworks (combining multilevel theories) represents a critical gap. This signifies an opportunity for future research to apply multilevel frameworks that combine behavioral theories with organizational theories to identify managerial and firm-level drivers.

Moreover, common theories that were applied throughout the literature are either sustainability theories (Amazonas et al., 2018) or strategic management theories (Del Gaudio et al., 2024) that indicate the studies have two common aims- protecting the environment (Ruiz-Molina et al., 2010; Razumova et al., 2015) and achieving competitive advantage (Guerlek & Tuna, 2018; Bani-Melhem et al., 2022; Gu, 2023). However, the lack of integrated theories provides evidence that we have limited knowledge about how both aim to work together in the context of a hotel.

In addition, these theoretical fragments push towards more relevant and applicable theory development. For example, (i) most existing studies defined adoption as a single event (such as installing a solar panel in a hotel). However, adoption consists of a series of activities, from learning technologies to testing and adapting them. Each stage has its

own drivers and barriers. Future process-based theories could be developed that could explain how green technology adoption evolves over time. (ii) Some of the studies assume that the same factors (for example, high investment cost) affect all kinds of hotels equally. However, it is not always true. A high-cost technology may be successful for a large chain but not for a budget hotel. Thus, researchers should develop configurational theories that could examine how different conditions result in successful technology adoption. (iii) Existing studies assume that green technology only has benefits, ignoring its negative consequences. For instance, adopting a smart water monitoring system may save water waste but can increase electricity consumption and maintenance costs. Future studies could prioritize developing a paradox theory that could explain how adoption could create conflicting situations.

Second, Context analysis (Fig. 4) suggests a geographical and contextual imbalance in that a considerable number of studies were conducted in the developed economies (68% studies), such as the USA and Spain, rather than in developing countries (Lucas et al., 2024; Qian & Zhang, 2023). This gap is crucial because the drivers, organizational decisions, or barriers vary across countries and regions (Marquez et al., 2023). For example, higher costs could be a substantial barrier for a developing economy, whereas this is not the case for developed economies (Ray et al., 2023). Moreover, theories from the developed economies might ignore the assumption that there is a scarcity of resources or constant sensitivity in developing economies (Neupane et al., 2025; Ray et al., 2023). Thus, a particular theory could not be generalized in all contexts. In addition, the study sector analysis (Fig. 4) demonstrates that the major focus of the studies considered the general hotel industry (40%) rather than star-rated hotels, implying that findings from the studies could not be generalized across hotel types (Chaudhary et al., 2025a; Akel & Noyan, 2024).

These inconsistencies could be attributed to three key factors (i) Research funds are more abundant in developed economies and create conducive setting for cross sectional researches (Pace, 2016; Fores, 2019) (ii) Journals might prefer studies from countries in which sustainability regulations are established (Gunduz Songur et al., 2023) (iii)

Theory development often prefer assumptions that are applicable globally not tailored to local conditions (such as TPB, RBV, stakeholder theory)

Third, Methodological bias is observed across studies. Analysis methods (Fig. 5 and Table 6) show that most of the studies are quantitative (51.6%) or cross-sectional surveys (Chaudhary et al., 2025a; Martínez-Rubio et al., 2024). Although these studies analyze and test the complex relationships (Pace, 2016; Fores, 2019), they cannot measure cause-and-effect analysis or longitudinal effects. Only a few articles adopted longitudinal studies or advanced methods such as fsQCA (Chaudhary et al., 2025b), indicating a 'grey area' that requires a further diversified approach in future studies focusing on green technology in hotels. Thus, the study argues that the field will benefit from three future research shifts: (i) Longitudinal studies could capture technology adoption patterns by studying a hotel over the years. (ii) prioritizing quasi-experimental designs that could be used, for example, to measure energy cost before and after installing solar panels (iii) adopting a mixed-method design could help triangulate and complement the cross-sectional study findings.

Fourth, the Antecedent-decision-outcome process inconsistency could be observed from the ADO relationship map analysis in Table 8. The relationship map indicates that organizational resources are the dominant driver, while environmental drivers, market pressure, and technological factors have a pronounced effect on overall decisions and outcomes. However, these antecedents are not always significantly translated to economic outcomes, as the analysis found 15 insignificant connections for economic outcomes and 8 for stakeholder value (see Table 8). These connections indicate that the link between antecedents and outcomes is not consistently supported in prior studies, indicating a need for further investigations and confirmations to clarify which drivers (or driver) are influential for a particular outcome.

Further, Table 8 reveals that hotel-related literature focused more on green technology adoption (such as energy management systems or water conservation systems) rather than sustainable process innovation (such as sustainable supply chains) and eco service transformation (involving guests in the waste management process) (Chaudhary et al., 2025a; Chaudhary et al., 2025d; Bani-Melhem et al., 2022). This indicates a crucial

research focus in that hotels are more inclined to visible devices rather than operational changes, customer engagement, or involvement in the process (Gomez-Conde et al., 2019; Legendre et al., 2024). Several factors might explain the pattern. (i) Technology adoption outcomes (such as energy savings) are easy to quantify and measure, which makes them appealing for hypothesis development in quantitative studies (Pace, 2016; Fores, 2019). Thus we can argue that as the majority of the reviewed studies are quantitative in nature, the larger proportion of studies focused on adoption outcomes (ii) Process innovations (such as redesigning supply chain) and customer engagement (such as towel reuse) are difficult to observe and measure with a quantitative approach because (iii) hotel managers might assume that investment in visible technologies will signal guests about hotel's environmental commitments while process modifications could even create service disruptions. (iv) Regulatory bodies generally prioritize more on resource consumption rather than on less visible process innovations within hotel operations (Menegaki & Agiomirgianakis, 2019).

Fifth, Outcome and mutual reinforcement among variables could be observed from the relationship map analysis. The map highlights that the most influential outcome is environmental performance, which is motivated by environmental and organizational resource antecedents. Similarly, economic performance and stakeholders' value outcomes are significant outcomes mostly derived from market and consumer pressure and organizational resources antecedents. However, a critical phenomenon could be observed from the analysis that it is possible that a particular outcome could influence future antecedents. For example, a positive brand image (stakeholder value outcome) (Chaudhary et al., 2025b) or reduced emissions (Nathaniel et al., 2023) (environmental performance outcome) could shape visitor's future hotel choice or customer demand (Market and consumer pressure) by enhancing trust, satisfaction, loyalty, attractiveness (Chaudhary et al., 2025a, 2025b; Fores, 2019) that could lead to other subsequent outcomes. Tracing the feedback loops (scientific validation) could result in managers' strategic competitive advantage and better market prediction.

However, why did the prior studies overlook these feedback loops? The reason lies in the literature structure itself, (i) as the studies were dominated by cross-sectional studies,

these studies measure variables at a single point of time and are not designed to measure reciprocal causality. (ii) dominant theories used in the prior studies, such as TPB, RBV, are static in nature and they predict adoption outcomes at a specific stage, not how those outcomes shape subsequent antecedent-outcome process. Future studies could employ dynamic theories such as system dynamics (Forrester, 1997) and organizational learning perspectives (Argyris & Schön, 1997) to capture feedback loops and longitudinal effects of green technology adoption.

Finally, the synergy of the ADO-TCM framework could be observed from the integration of both frameworks. Individually, these frameworks have distinct functions, such as TCM, which maps what theories and methods (Lim et al., 2021) were used in prior studies, whereas ADO discovers how the antecedents lead to decisions and outcomes (Paul & Benito, 2018). Combining both frameworks depicts a complete picture of how concepts link with causal relationships. For example, TCM analysis suggests that behavioral and psychological theories, such as TPB, were adopted in understanding managers' motivation; ADO analysis then, drawing on the TPB theory, supports and strengthens the causal relationships, such as manager's positive attitude towards sustainability (antecedent) leads to implementing an employee green workshop (Decision) that further results in higher environmental performance of the hotel. Creating a bridge between macro-level theory and micro-level causal relationships is the key contribution of the study.

However, this integrated framework raises an inherent question: whether the same causal pattern holds true in underrepresented contexts such as developing economies or budget hotels. The answer is unknown from the evidence of current literature, but it indicates what factors or areas of research are missing to generalize the study findings and causal relationships.

4.2 Future Research Directions

The study analysis of the ADO and TCM framework unveiled crucial gaps and recommended subsequent research direction. Following the structure of Kumar & Kushwaha (2025), the study identified the critical gaps in six significant areas: Theories, Context, Methods, Antecedents, Decisions, and Outcome, and later recommended future direction based on those gaps.

Table 9: Proposed Future Research Directions

Dimensions	Research Question	Supporting citations
Theories	How individual behavioral (such as TPM) and organizational (such as RBV) theories could be integrated to investigate the green technology adoption in hotels	Clark et al. (2025) (TPB); Chaudhary et al. (2025b) (RBV); Bani-Melhem et al. (2022) (multi-level theory) see Table 5
	Why are sustainability theories, such as the Triple Bottom Line, used frequently in green technology literature, whereas those studies show weak ADO connections (specifically economic and stakeholder outcomes)? Is it because of the misdefinition of outcome variables or the lack of longitudinal data?	Elzek et al. (2021) and Gu (2023), see Table 8 (showing weaker connections for economic and stakeholder outcomes with significant negative links)
	How can Paradox Theory (Lewis, 2000) explain trade-offs (environmental gains vs costs, guest satisfaction vs resource utilization) in the green technology adoption process?	Ray et al. (2023). Marquez et al. (2023), see Table 8 (showing lack of paradox theory)
Context	Are the same antecedents of green technology adoption predicting environmental outcome in developing economies hold true for developed countries, or context-specific models are required?	Lucas et al. (2024). (Asia/Africa comparison); Neupane et al. (2025) (Nepal); Marquez et al. (2023) (Peru); Amazonas et al. (2018) (Brazil).
	How do regulatory pressures and cost constraints shape adoption differently in emerging markets compared to developed economies?	Razumova et al. (2015) (regulation in Spain); Gu (2023) (regulation in China); Bani-Melhem et al. (2022) (constraint study)
Method	What is the causal effect of green technology adoption on economic performance over a 3-year period, controlling for hotel size and market segment?	Table 7 shows a lack of longitudinal studies; most are cross-sectional.
	What combinations of antecedents or drivers result in successful adoption, using configurational methods such as fsQCA or cluster analysis?	See table 7 (Only a few 62 articles used such methods (Chaudhary et al., 2025b; Sun et al., 2021; Pérez-Pineda et al., 2017)
Antecedents	How do market and consumer pressures interact with resource constraints in small versus large hotels?	Amazonas et al. (2018); Ray et al. (2023); Neupane et al. (2025). No comparative study by size. See Table 8
	Do barrier factors (such as high cost, lack of awareness, and regulatory complexity) moderate the effectiveness	Table 8 shows 18 negative connections but no moderation tests. Marquez et al. (2023);

	(or driver-outcome relation) of other positive antecedents?	Razumova et al. (2016); Ray et al., 2023)
	What is the relative weight of technological antecedents in comparison to organizational resources in predicting environmental and economic outcomes?	(Del Gaudio et al., 2024; Menegaki, 2018; Martínez-Rubio et al., 2024).
Decisions	What organizational capabilities enable hotels to shift from installing or adopting green technologies to implementing process innovations?	(Dias et al., 2021; Gomez-Conde et al., 2019; Khatter, 2025). Table 8 shows 24 process innovation connections vs 57 adoption connections.
	Hotels that adopt process innovation, do they achieve long-term economic performance more than those that only install visible technologies?	Elzek et al. (2021), Fores (2019), and Periyannan et al. (2023)
Outcomes	How do environmental and stakeholder outcomes create reinforcing or balancing feedback loops that affect future adoption decisions of hotels? What are the time lags involved? What contextual settings are influential in the process?	The study analysis (Table 8) revealed a lack of studies aiming to measure the feedback loop.
	Why are economic outcomes sometimes inconsistently linked to antecedents? Is this due to short-term focus or the moderation (context) effect?	15 insignificant connections in Table 8. Gu, 2023; Qian & Zhang, 2023; Ray et al., 2023; Razumova et al., 2016.
	Under what conditions can green technology investments produce negative economic outcomes?	Table 8 shows 8 negative economic outcome links. Marquez et al., 2023; Ray et al., 2023; Razumova et al., 2016

Source: Author's analysis

5. Implications of the study

The systematic review based on integrated frameworks successfully dissects the literature studying green technology adoption in the hotel industry. The implications (theoretical and practical) are derived from the reviewed 62 articles of the study and the consequent current study analysis, and the frequency of relationships reported in Table 8 reflects the degree of scholarly attention. The implications should not be interpreted or translated as proven causal strength or operational effectiveness.

5.1. Theoretical implications

The study proposes theoretical implications in several ways.

First, the current study findings support the core assumptions of several foundational theories based on our reviewed articles. For example, the ADO analysis found that government regulations, hotel industry practices or standards, and society expectations are dominant antecedents (Ali et al., 2023; Nathaniel et al., 2023; Razumova et al., 2015). These findings support the arguments of the institutional theory (DiMaggio & Powell, 1983) that explains how coercive, normative, and mimetic pressures shape the hotel's environmental strategies and compliance practices. Likewise, findings, such as pressure or expectations from hotel guests, local community, and investors that form the strategic decisions to adopt green technologies (Del Gaudio et al., 2024; Bani-Melhem et al., 2022), validate the stakeholder theory's primary assumptions (Freeman & Phillips, 2002). However, these theories were applied in studies (68%, see section 3.2.2) that considered mostly developed economies. Therefore, their generalizability remains unverified, and future research should address this.

Second, Findings indicate the extended understanding of theories through distinguishing contextual layers. For example, the study extends the scope of Technology Adoption Theories, such as UTAUT and Diffusion of innovation, by clarifying that their applicability is not all-inclusive. Rather, green technology adoption varies fundamentally between luxury hotels that emphasize guests' technology interaction or experience (Wu et al., 2025) and budget hotels that stress cost-saving (energy-saving) technologies (Khatter, 2025). Such understanding could enhance the predictive validity of green technology adoption models and support theory development that could reflect the heterogeneity of hotels.

Third, the study identified that the nature of green technology adoption by hotels is complex in that the process requires individual (managerial) and organizational (hotel) decision-making (Ray et al., 2023; Dias et al., 2021). In consequence, single theories such as TPB (explaining individual behavior) or RBV (explaining organizational strategic advantage) would explain green technology adoption partly. Therefore, a key theoretical contribution of the study is the identification of a pressing need for multi-level theoretical integration to better model the technology adoption. This integrated approach helps the literature shift toward a more configurational and system-based understanding rather than an isolated, segmented conceptualization of green technology adoption.

Fourth, contextual bias, such as the majority of the studies employed in developed economies (Del Gaudio et al., 2024; Qian & Zhang, 2023), poses a serious question whether the theory developed in a developed economy, such as the USA, could be applied in less developed or developing economies (such as India). The study identified the gap as crucial and recommends that future studies should either develop context-specific theories or apply an integrated approach combining theories of internal capabilities with theories of external pressure. Thus, the study argues that context should be theorized as a source of variation rather than treating it as neutral empirical settings.

Finally, a substantial contribution of the study is the integration and employment of the TCM-ADO framework. The study, in the context of green technology adoption, further unified and strengthened the TCM-ADO framework integration, arguing that it could be defined as a unified process and could be explained through Dynamic Capabilities Theory (DCT) (Teece,2007). Teece in his extended DCT, claimed that the dynamic capability of a firm could be explained through three core processes: ‘sensing’, ‘seizing’, and ‘transforming’. Similarly, grounded on DCT, hotels through TCM ‘sense’ the external landscape. Theories, such as stakeholder theory, explain the hotel's surrounding pressure and customs, whereas contextual understanding helps comprehend environmental conditions, such as societal regulations and market conditions, and method trend reflects how knowledge was validated and how effective it would be. TCM represents the awareness stage before the commencement of the decision process.

ADO defines the core process as Antecedents represent the ‘sensing’ capability through which hotels recognize the vital opportunities and pressures, and Decisions represent seizing capability that explains how hotels take action, such as green technology investment or process innovation decisions. Outcome indicates transforming capability that helps reconfigure operational processes to achieve improved environmental performance and competitive advantage. This integration addresses a key observation of the study that green technology adoption literature theories are fragmented. Drawing on DCT as an umbrella theory, the study offers a comprehensive process model that connects macro environmental sensing with micro-organizational decision and outcome. This process establishes a solid foundation for future research.

5.2. Practical implications

The study findings, especially ADO-based findings, help guide the hotel manager and policy makers in adopting evidence-based strategic decisions and implications, although they require careful organizational and contextual considerations rather than proven best practices.

First, the literature suggests that managers should seek a dedicated budget for green technology adoption because the relationship map (Table 8) pointed out that organizational resources are the strongest driver (with the highest number of positive connections with adoption decision and outcomes). The study further suggests that such resource allocation should not be limited to technology acquisition but should also include complementary support activities. For instance, they should emphasize infrastructure, staff training, and advanced technological capabilities.

Second, the major challenge of green technology adoption identified in the literature is substantial initial investment and limited awareness (Ray et al., 2023; Razumova et al., 2016). Based on the findings, managers could move beyond cost concern and adopt strategic logic. For example, they could assess lifecycle cost analysis of green technology adoption, including savings from energy efficiency, waste reduction, and gaining organizational reputation. In consequence, future cost savings could be considered for initial investment decisions. In the meantime, they could try to reduce adoption barriers by seeking external support, such as exploring government grants or green financing.

Third, the prior research confirmed that technological drivers such as technology ease of use or reliability are crucial for adoption of technologies (Chaudhary et al., 2025a; Wu et al., 2025). Therefore, the manager, when introducing new technology in the hotel, should be cautious about device-employee fit and launch appropriate training to ensure employee effectiveness. Further, managers should go beyond the simple installation of technology and try to transform guest experiences through process innovation. For example, a hotel could encourage guests to reuse towels, which will contribute to the tree plantation program of the hotel. Such practice might strengthen the practical influence of green technology and the hotel’s sustainability image among guests.

Finally, hotel categories based on customer expectation, cost structure, and service priorities play an influential role in determining which strategy will be effective for green technology adoption. For example, high-end luxury hotel guests value green technology engagement (such as smart room control, smart thermostat) (Chaudhary et al., 2025c; Qian & Zhang, 2023), whereas budget hotels would benefit from adopting high-return technology adoption (such as water saving technology, green lighting system (Li et al., 2024; Ray et al., 2023). Therefore, managers should align green technology investments with the specific strategic position, customer segment, and economic priorities of their hotel.

6. Limitations and Conclusion

6.1. Limitations

Though the review pointed out several crucial findings and implications, the study is not limitation-free. First, the initial limitation could be the search strategy employed in the study, which might limit the search results. For example, terms like ‘smart building system’ or ‘eco-efficiency practices’ could appear in engineering articles that do not even mention ' green technology’. The inclusion and exclusion criteria were considered, such as considering only peer-reviewed journal articles, English language articles, and selecting only two databases (Scopus and Web of Science). These phases could rule out important research work that might be published as a book chapter, conference proceedings, or published in other languages. Further, not considering other databases such as EBSCOhost could result in a limited collection. However, the decision to include Scopus and Web of Science databases was methodologically justified. (Sánchez et al., 2017)

Second, the TCM-ADO combined framework is the central contribution of the study. But it might restrict prior literature exploration through other theoretical lenses. TCM-ADO is grounded on several restricted dimensions such as theories, methods, outcomes, or causal pathways. The framework could miss other crucial dimensions, such as ethical dimensions, power dynamics, etc. For example, the ADO framework is not designed to capture feedback loops (outcome-reinforcing antecedents). Third, the results and analysis are extracted from published literature. That means the findings will reflect the observations, constructions, and measurements of the original article, not from the hotel

operations. This limits the review insights to be translated into the real-world implementation.

Fourth, the ADO framework, which focused on a linear causal relationship (antecedents-decisions-outcomes), might oversimplify the process. For example, there might be other factors influencing the relationship that were ignored in the prior empirical research. Moreover, there could exist a relationship loop, which was ignored in the ADO framework. In addition, the relationship map was formed by a voting method. In spite of ensuring inter-rater reliability ($\kappa = 0.87$), the degree of personal evaluation involved in categorizing and coding in the map cannot be ignored.

Finally, as the systematic review is based on content analysis and the researched topic is complex, a meta-analysis should be conducted so that the robustness of the study is ensured.

6.2. Conclusion

This systematic review synthesized 15 years of research (2010-2025) on green technology adoption in hotels through an integrated TCM-ADO framework and considered 62 peer-reviewed journal articles. Its purpose was not to test causal hypotheses but to map intellectual structure, identify dominant theoretical and methodological patterns, and compile the antecedent-decision-outcome relationships based on the existing literature reviewed. The study resolved critical gaps in the field by addressing the research questions (RQ1-RQ4), achieving subsequent research objectives.

First, the study mapped the historical evolution of the field (RQ1), then second, the TCM framework systematically analyzed the scattered theoretical applications by categorizing distinct theories into six themed clusters (Table 4) (RQ2). The study revealed the dominance of sustainability, Behavioral and psychological, Strategic, and Sustainability theories. Third, to address RQ3, the ADO framework mapped the complex causal relationships or links, revealing that organizational resources are the most significant antecedent, enabling green technology adoption decisions. Finally, addressing RQ4, the

study interpreted the key theoretical contributions, recommended practical implications, and proposed key areas of future research directions.

From the perspective of theory, the review reveals that green technology adoption is a multi-level phenomenon, although the field continues to rely on single-level theories. For practice, the review identified several connections relating to antecedents to adoption and outcomes. The study argues that these patterns reflect research emphasis, not proven practical causality, and caution is required when applying them in real-world scenarios. For society, the study supported that the green technology adoption is linked to environmental benefits, yet the evidence relied heavily on developed economies. The study synthesis indicates critical gaps rather than definitive causality.

7. Declaration

7.1. Funding: No specific funding obtained for the current study

7.2. Data availability: Not Applicable

7.3. Ethical approval: Not applicable.

7.4. Consent to participate: Not Applicable

7.5. Consent to publish: Not Applicable

7.6. Clinical trial number: Not applicable

7.7. Competing interests: No competing interests have been declared by the authors.

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