Intelligent Booking Systems for Natural Resources and Urban Development: A Geospatial SLR

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Abstract—**Rapid urbanization and increasing pressure on natural resources demand efficient, transparent, and sustainable management systems. However, existing booking systems in government agencies often operate in silos and lack integration with geospatial data. This study conducts a Systematic Literature Review (SLR) to identify essential components of intelligent booking systems (IBS) and research gaps in the context of Natural Resources and Urban Development with geospatial data integration. The SLR follows a three-phase protocol (Planning, Execution, Reporting). The literature was searched in IEEE Xplore, SpringerLink, ScienceDirect, and ACM Digital Library for 2021–2025. From an initial pool of 40 articles, 16 were selected for in-depth analysis after eligibility and quality assessment (scoring ≥ 3 out of 5). The analysis reveals six main component categories, with Resource Management (n=12) and Booking Management (n=11) as the foundational layers, whereas Geospatial Integration was addressed in only 4 of the 16 studies. Critically, no existing system integrates Sentinel satellite data (Sentinel-1/2), and no optimisation model combines Multi-Criteria Decision Making (MCDM) with GIS for this specific domain. This SLR provides a comprehensive component framework and systematically maps four key research gaps, laying a foundation for developing geospatially-integrated intelligent booking systems for smarter natural resource and urban facility allocation.**

Keywords—Intelligent booking systems; natural resource management; Geographic Information Systems (GIS); satellite remote sensing; data mining; Multi-Criteria Decision Making (MCDM)

I. Introduction

With rising population and urbanization, efficient public service delivery and organizational resource utilization have become critical. Many government agencies still rely on outdated, fragmented, or partially digitized booking procedures that fail to meet modern requirements.

For this research, we focused on Sarawak, Malaysia. Reservations are typically handled through paper forms, emails, phone calls, or stand-alone spreadsheets [1], [2]. Such ways do not work consistently across departments because there is no common platform to manage available resources. Besides the lack of integration with geospatial data, the current methods also cause double-bookings, scheduling conflicts, delays, and inefficient allocation. There is also poor visibility of resource availability and a lack of historical records. Although these issues may seem minor administratively, together they create a significant burden, reducing productivity and the efficiency of public service delivery.

Malaysia launched its Public Sector Digitalisation Strategy to address these operational hurdles. While significant investments have been made in enterprise systems such as electronic document management, HR, and financial systems. Little attention has been paid to booking and reservation processes. Current systems function mainly as electronic calendars without intelligent decision support, making them transactional rather than adaptive or predictive.

Advances in AI, data analytics, optimization, and decision support have enabled the creation of Intelligent Booking Systems (IBS). IBS go beyond traditional reservation tools by offering features such as conflict detection, resource optimization, recommendations, demand forecasting, priority-based scheduling, and real-time decision support [3], [4]. Previous studies have demonstrated IBS applications across transportation (e.g., EV charging, parking prediction) and hospitality (e.g., tourism marketing, personalized travel) [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18]. IBS adoption in government remains limited.

A major weakness in booking systems is the absence of geospatial integration. Sentinel-1 and Sentinel-2 satellite data provide crucial information on location, land cover, environmental changes, and zoning. All highly relevant for resource management [19], [20]. Practical experience at Spectral Imaging Services and the Ministry of Natural Resources and Urban Development Sarawak demonstrates the potential of Sentinel data to improve booking decisions. Although GIS and remote sensing technologies are mature, integration into booking systems for natural resource and urban domains remains scarce [21], [22].

Government organizations face unique challenges compared to commercial ones. They operate under governance policies, regulatory constraints, hierarchical decision-making, security standards, and interdepartmental resource sharing. Booking decisions often follow organizational priorities rather than "first come – first served." Thus, systems must ensure auditability, policy enforcement, transparency, fairness, and compatibility with other government information systems.

Most IBS studies focus on narrow areas such as healthcare, laboratories, transportation, hotels, and libraries. Most previous research does not address government-specific needs [23].

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While systems provide features like predictive analysis, automated allocation, adaptive scheduling, conflict resolution, workflow automation, decision support, and performance analysis. These are implemented separately, resulting in poor integration for administrative decision-making. No existing system combines Sentinel satellite data with IBS or integrates Multi-Criteria Decision Making (MCDM) with GIS for resource and urban facility management [24], [25].

Developers lack a structured framework for IBS design in government, leading to ad hoc development, inconsistent functionality, poor interoperability, low scalability, and varied implementation quality.

To address these gaps, this research will conduct a Systematic Literature Review (SLR). This study identifies, synthesizes, and categorizes IBS components from contemporary literature. Following the established SLR protocol by Lane and Richardson [26], the SLR includes planning, execution, and reporting phases. The research questions are:

- What are the core IBS components recognized in literature?
- How should these components be adapted for natural resource and urban development domains?
- What components and interfaces are required to integrate geospatial data (GIS and satellite imagery)?
- What research gaps remain, and how can they inform future studies?

The review will cover peer-reviewed journal articles and conference proceedings published between 2021–2025 in IEEE Xplore, SpringerLink, ScienceDirect, and ACM Digital Library. The 2021–2025 timeframe was deliberately chosen to capture recent breakthroughs in AI, optimization algorithms, and GIS technologies, which have evolved substantially in the post-pandemic period, making earlier literature less representative of current system capabilities. Scopus was excluded as coverage from the four databases was deemed sufficient. Books, chapters, editorials, dissertations, and grey literature will be excluded to maintain methodological consistency.

The article follows the IMRaD structure. Starting from methodology (SLR protocol and paper selection), findings (IBS component classification and gap identification), discussion (linking findings to government requirements), and conclusion (contributions, limitations, and future directions).

II. Methodology

This Systematic Literature Review (SLR) follows the three-phase protocol by Lane & Richardson [26]. This study follows the planning, execution, and reporting phases as defined in the protocol. The focus of this research is to identify, synthesize, and categorize IBS components and research gaps, particularly for natural resource and urban domains with geospatial integration.

A. Search Strategy

We searched four significant databases (IEEE Xplore, SpringerLink, ScienceDirect, ACM Digital Library). We selected peer-reviewed articles published 2021–2025. Scopus was excluded as these four databases provided sufficient coverage. Scoping searches conducted before the main search confirmed that the four selected databases already covered the core computer science, information systems, and engineering journals relevant to this topic, and no additional eligible records were uniquely found in Scopus. Table I details the Boolean search strings and initial results.

TABLE I. Search Strategy and Keywords

Database	Keywords / Search String	Initial Results
IEEE Xplore	("intelligent booking" OR "smart reservation") AND ("GIS" OR "geospatial") AND ("natural resource" OR "urban")	3
SpringerLink	("intelligent booking system" AND ("GIS" OR "geospatial") AND ("resource" OR "urban"))	16
ScienceDirect	("intelligent booking" OR "smart reservation") AND ("GIS" OR "geospatial")	17
ACM Digital Library	("intelligent booking" OR "smart reservation") AND ("GIS" OR "geospatial")	4
Total		40

To quantitatively validate the adequacy of the selected databases, a supplementary scoping search was conducted in Scopus on 15 August 2026 using the identical Boolean string applied to the primary databases: ("intelligent booking" OR "smart reservation") AND ("GIS" OR "geospatial"). Unlike the primary searches, which targeted full-text content across IEEE Xplore, SpringerLink, ScienceDirect, and ACM Digital Library, this validation search was executed across all fields in Scopus to maximise recall. The Scopus search returned only 5 records. A manual title and abstract screening of these 5 records revealed that none met the eligibility criteria: four were focused on tourism, cybersecurity, or metaverse applications without any booking system component, and one was a survey of parking solutions that did not present an intelligent booking system or geospatial integration for natural resource or urban development domains. Consequently, no unique eligible records were identified in Scopus beyond those already captured by the four primary databases. Table II summarises the comparative coverage validation, confirming that the selected databases provide comprehensive and representative coverage for this systematic literature review.

TABLE II. Validation of Database Coverage

Source	Initial	Unique	Relevant
IEEE Xplore	3	3	2
SpringerLink	16	16	8
ScienceDirect	17	17	5
ACM Digital Library	4	4	1
Scopus (Validation)	5	5	0

Notes: Initial = total records retrieved from the database; Unique = records remaining after deduplication against the four primary databases (or within the pooled corpus); Relevant = records that passed the title/abstract screening and eligibility criteria (quality score ≥ 3). The Scopus validation search returned 5 records, all of which were excluded after screening as they did not address intelligent booking systems with geospatial integration for natural resource or urban development domains.

B. Inclusion and Exclusion Criteria

In this research, we included English-language, full-text, peer-reviewed journal articles and conference proceedings. The focus of article content that discuss booking/reservation systems employing intelligent technologies (AI, optimization, or ML). We also consider GIS/geospatial discussion as an added value but not mandatory for RQ1. Excluded were books, book chapters, editorials, non-English articles, studies lacking intelligent/optimization elements, and those without GIS relevance (unless highly relevant to core booking components).

C. Study Selection Process

Selection followed the PRISMA 2020 flow [29]. We identified database searches and deduplication. Besides screening (title/abstract review), eligibility (full-text assessment against criteria), and inclusion (final dataset). Results of our article selection are presented in Fig. 1.

Each article was evaluated with a quality score (0–5). The scoring criteria included clarity of objectives, methodological depth, completeness of system description, discussion of intelligent aspects, and relevance to GIS. Studies scoring <3 were excluded. The scoring rubric was as follows: clarity of objectives (0–1), methodological depth (0–1), completeness of system description (0–1), discussion of intelligent aspects (0–1), and relevance to GIS (0–1), for a maximum total score of 5.

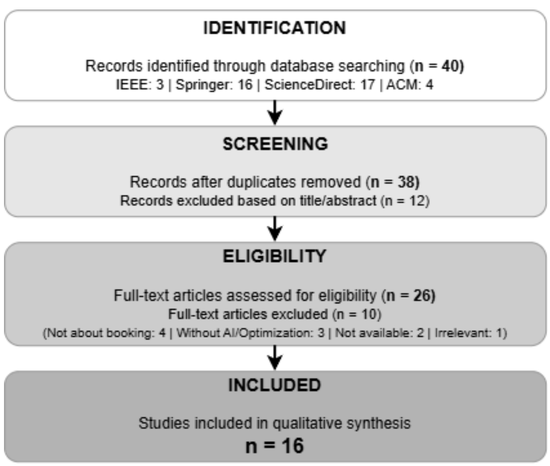

Fig. 1. PRISMA 2020 study selection process flow diagram (modified from[27]).

D. Quality Assessment

From each eligible study, we extracted bibliographic data, research objectives, methodologies, system components, intelligent techniques, GIS relevance, application domain, key findings, and identified gaps. Data were analyzed thematically [27] through coding, categorization, theme identification, and narrative synthesis to map IBS components and integration requirements.

E. Data Extraction, Analysis, and Study Management

From each eligible article, we extracted data on bibliographic details, research objectives, and methodology. We also recorded system components, intelligent techniques such as AI and optimization, and GIS relevance. In addition, application domains, key findings, and research gaps were documented using a standardized form.

Data synthesis was conducted using thematic analysis. This process involved iterative coding, which grouped components by function, such as scheduling, optimization, and GIS. The coding was followed by categorization and narrative synthesis to ensure a structured mapping of IBS architectures and integration needs.

The review process was managed using Mendeley for reference storage. Excel spreadsheets were used for selection, quality assessment, and extraction tracking. Each study was assigned a unique identifier (S1, S2, …). This ensured traceability throughout the review.

III. Results

A. Search Results and Study Selection

The literature search was conducted across four academic databases. We used IEEE Xplore, SpringerLink, ScienceDirect, and the ACM Digital Library, as described in the search strategy in Section II. The initial search yielded a total of 40 articles. Specifically, 3 articles were from IEEE Xplore, 16 from SpringerLink, 17 from ScienceDirect, and 4 from the ACM Digital Library.

The study selection process followed the PRISMA 2020 flow diagram, which is recommended for SLR reporting [27]. The flow diagram is shown in Fig. 1. It maps the number of articles identified, included, and excluded at each stage. It also presents the reasons for exclusion.

TABLE III. Mapping of Included Studies to IBS Component Categories

ID	Author & Year	Domain	Primary Category(ies)
S1	Sun & Song (2021) [28]	Timetabling	Booking, Intelligence
S2	Sadreddini et al. (2021) [29]	EV Parking	Resource, Booking, Intelligence
S3	Al-Khatib et al. (2022) [30]	Vehicular	Resource, Booking, Intelligence
S4	Muzzini et al. (2023) [31]	Smart Parking	Resource, Intelligence
S5	Ting et al. (2024) [32]	EV Charging	Resource, Geospatial, Intelligence
S6	Wang (2023) [33]	Laboratory	Resource, Booking, Intelligence
S7	Zhou (2025) [34]	Stadium	Resource, System, Intelligence
S8	Channamallu et al. (2026) [35]	Urban Parking	Resource
S9	Yadav et al. (2026) [36]	EV Charging	Booking, Intelligence
S10	Lv et al. (2026) [37]	Parking	Resource, Intelligence
S11	Han & Wang (2025) [38]	EV Charging	Booking, Intelligence
S12	Navpreet et al. (2025) [39]	Parking	Resource, Intelligence
S13	Fatema et al. (2026) [40]	Tourism	Booking, Intelligence
S14	(X. (Simon) Zhou et al., 2025) [41]	Transportation	Geospatial, Intelligence
S15	Zayat et al. (2023) [42]	Industry 4.0	Intelligence
S16	Gurung et al. (2025) [43]	Transportation	System

The selection process was conducted in four stages. The Identification stage produced 40 articles from four databases.

The Screening stage removed 2 duplicates, leaving 38 articles. After screening titles and abstracts, 12 articles were excluded because they were not relevant to the research topic. This left 26 articles. The Eligibility stage involved full-text reading of these 26 articles. At this stage, 10 articles were excluded. The reasons were: 1) did not substantially discuss intelligent booking systems (n=4), 2) did not include intelligent or optimization aspects (n=3), 3) full-text was not available (n=2), and 4) not relevant to natural resource or urban domains (n=1). Examples of excluded studies include a sports teaching application without intelligent booking components, a study on recreational prawn fishing focused only on consumer behavior [18], and a grounded theory study on voluntary blood donation outside the scope of booking systems [44]. The Inclusion stage resulted in 16 final articles that met all quality criteria for further analysis.

Based on the analysis of 16 articles, the publication distribution shows an increasing trend in recent years. The growth is especially visible since 2020. This indicates a rising research interest in intelligent booking systems. The focus is particularly on systems that integrate artificial intelligence and optimization technologies. Most of the articles come from journals and conference proceedings. They are mainly in the fields of computer science, information systems, and engineering.

B. Characteristics of Included Studies

From the 16 articles that passed the selection, data extraction was conducted to identify the characteristics of each study. Table III presents a summary of the characteristics of each reviewed article.

C. Classification of Intelligent Booking System Components

Based on thematic analysis of the 16 reviewed articles [45], the components of intelligent booking systems can be classified into six main categories. Table IV presents a summary of the component classification along with the number of studies addressing each category.

TABLE IV. CLASSIFICATION OF INTELLIGENT BOOKING SYSTEM COMPONENTS

Category	Components Identified	Studies (n)
Resource Management	Resource inventory, availability status, geospatial location, resource categorization, charging/parking space management	12
Booking Management	New booking, modification, cancellation, recurring booking, approval workflow, reservation algorithms	11
Intelligence (AI/Optimization)	Smart scheduling, conflict detection, recommendation engine, resource optimization, predictive booking, MADM, heuristic optimization, multi-agent RL	10
Geospatial Integration	GIS interface, satellite data integration, interactive mapping, zoning analysis, location verification, spatial placement	4
System Integration	IoT integration, Outlook/Google Calendar, HR system, facility management, digital workplace, cloud connectivity	8
Security & Compliance	Access control, Single Sign-On (SSO), audit trail, data protection, privacy, regulatory compliance	5

First is Resource Management. It includes bookable resources such as inventory, availability, location, categorization, etc. Most of the articles covered this element. It shows that any booking system is built on resource management.

The second category is Booking Management. It manages the booking lifecycle: new bookings, modifications, cancellations, recurring bookings, and approvals. This component was consistent across the literature. This is the heart of what a booking system does.

The third category is Intelligence. It is the most diverse and distinguishes the conventional from the intelligent systems. Features include smart scheduling, conflict detection, recommendations, optimization, and predictive booking. Compared with tourism and service industries, research on the application of MCDM to booking systems is still limited [42].

The fourth category is Geospatial Integration. It is the least common we find in the literature. Components. GIS interfaces, satellite data, mapping, zoning, location validation. This suggests that geospatial integration remains an under-explored area. Studies [32] and [41] did not use remote sensing but only simple location data or IoT.

The fifth category is System Integration. It links booking systems to calendars, HR, and facility management. Its importance is mentioned in the literature from other domains. These include IoT-enabled facility management and AI-powered web architectures in e-commerce and healthcare [46]. Other studies such as IoT-based transport frameworks [47] and digital transformation in railways [48] illustrate how interoperability can be achieved in public sector environments.

The sixth category is Security and Compliance. This protects data and ensures regulatory compliance. It provides access control, single sign-on, audit trails, and data protection.

TABLE V. SUMMARY OF RESEARCH GAPS IDENTIFIED FROM THE LITERATURE

Gap ID	Research Gap	Supporting Evidence from Included Studies
G1	No intelligent booking system integrating satellite data (Sentinel)	Out of 40 reviewed articles, none utilized satellite imagery (Sentinel-1/Sentinel-2) for location verification or environmental analysis. Studies such as Ting et al. (2024) and X. (Simon) Zhou et al. (2025) only employed basic location data or IoT, not remote sensing data.
G2	No optimization model combining MCDM with GIS for natural resource domains	Zayat et al. (2023) discussed MADM in general for Industry 4.0, but no study integrated it with GIS-based spatial analysis for natural or urban resource allocation.
G3	No comprehensive guideline on booking system components for natural resource and urban domains	Most studies (e.g., Sadreddini et al., 2021; X. Wang, 2025; S. A. Zhou, 2025) focused on specific domains (laboratories, stadiums, parking) without providing an integrated component framework that could be replicated for natural resources.
G4	Government booking systems still operate in silos	None of the 16 included articles addressed cross-system interoperability or inter-agency integration. All solutions were single-domain or single-organization.

D. Research Gaps Identified

Based on the analysis of the reviewed literature, several significant research gaps were identified. Table V summarizes the identified gaps along with supporting evidence from the literature.

Gap 1: Satellite Data Integration. The most significant finding of this SLR is the absence of intelligent booking systems that integrate satellite data (such as Sentinel-1 and Sentinel-2) into the booking process. Satellite data provides critical information about location, land cover, and environmental changes that is highly relevant for decision-making in natural resource management and urban planning.

Gap 2: MCDM + GIS Optimization Model. Although MCDM has been used in various fields such as tourism and education, its application to booking systems for natural resource and urban domains integrated with GIS remains very limited. No optimization model comprehensively combines these two approaches.

Gap 3: Domain-Specific Component Guidance. Existing literature on booking system components is mostly generic or developed for specific domains such as libraries or laboratories. No guidance or component framework has been specifically designed for natural resource and urban development domains.

Gap 4: Siloed Systems in Government Agencies. Most research on booking systems focuses on solutions for a single domain or specific organization. There is limited research addressing integration across systems in government agencies that still operate in silos.

E. Initial Conceptual Map

Based on the component classification findings in Table IV, an initial conceptual map can be drawn showing the relationships between components in an intelligent booking system. This map is synthesized from the literature. It serves as the basis for the framework proposed in the Discussion section.

The conceptual map shows that the components of an intelligent booking system are interconnected and interdependent. Resource Management and Booking Management form the core of the system. Intelligence and Geospatial Integration add extra layers that provide value. System Integration and Security and Compliance act as supporting layers. They ensure the system can operate within a broader ecosystem and meet security standards.

IV. Discussions

This section discusses the findings presented in Section III. The discussion answers the four research questions (RQs) that have been formulated. It also analyzes the implications of the findings from the 16 reviewed articles. In addition, the section identifies the research limitations. The structure of the discussion follows the logical flow from RQ1 to RQ4. It concludes with a synthesis that connects the findings to the research contributions.

A. Core Components of Intelligent Booking Systems (RQ1)

Six main categories of intelligent booking system components were identified, extending the earlier five-component framework by Owonibi et al. [49]

Resource Management and Booking Management are the foundational elements, present in nearly all studies, covering inventory, recording, modification, cancellation, and approval workflows [28], [29], [33].

Intelligence is the key differentiator from conventional systems, enabling optimization, conflict detection, and recommendations. Research on MCDM in booking systems is still limited, leaving room for further exploration [50], [42].

The most important new finding is Geospatial Integration. The use of GIS and remote sensing technologies in booking systems is underexplored despite mature technologies and is one of the major contributions of this SLR. Supporting layers are System Integration and Security and Compliance. They provide interoperability with other organizational systems (e.g., calendars, HR) and security and regulatory compliance [51].

B. Component Modifications for Natural Resource and Urban Domains (RQ2)

The SLR results show that the generic components identified in RQ1 should be adapted and extended to address the specific needs of the natural resource and urban development domains. These changes concern three main aspects.

The first step is to require geospatial data to be a property of every resource managed by the system. In conventional reservation systems, resources are usually identified by name, code, or category only. However, in the natural resource and urban domains, each resource (e.g., land plots, forest areas, public facilities) needs to be accurately described by location attributes, including geographic coordinates and boundary areas. This is consistent with the literature on spatial data infrastructure that identifies the importance of location as a key attribute in all resource management decisions [52].

Second, the addition of zoning protection and eligibility rules as constraints in the booking system is required. Unlike booking lecture rooms or laboratories, which are relatively simple, booking natural resources involves more complex rules, such as utilization quota limits, environmental protection zoning, and user eligibility requirements. This finding aligns with research on natural resource management that emphasizes the importance of zoning and utilization rules in maintaining environmental sustainability [1], [2].

Third, the system must be equipped with automatic location verification capabilities based on geospatial data. This capability enables the system to automatically verify whether the requested location is within an allowed zone, whether there are conflicts with existing land use, and whether it complies with applicable spatial plans.

C. Components for Geospatial Data Integration (RQ3)

Based on the SLR findings and domain requirements analysis, the components required to integrate geospatial data into intelligent booking systems can be identified. Fig. 2 presents the proposed component framework for geospatial integration in intelligent booking systems.

The proposed framework (Fig 2) shows that geospatial integration requires four main components:

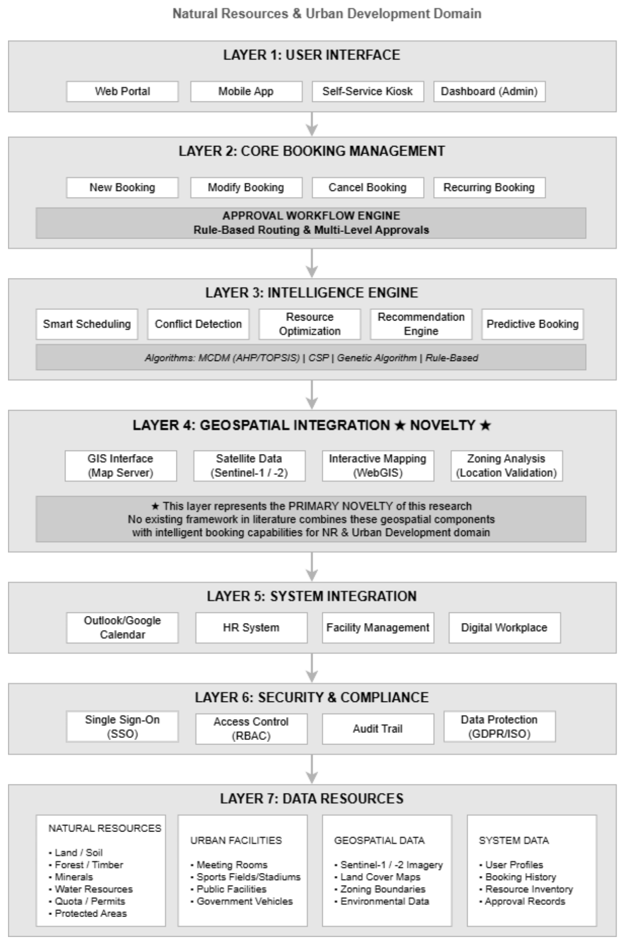

Fig. 2. Proposed component framework for intelligent booking system in natural resources and urban development.

1) GIS interface: A layer that connects the booking system to a map server to display spatial data interactively. This interface enables users to view resource locations on a map, select resources based on location, and visualize spatial conflicts. This finding aligns with research on web-based geographic information systems that emphasize the importance of intuitive interfaces for user adoption [53].[53]

2) Satellite data integration: The capability to consume and process satellite imagery data (such as Sentinel-1 and Sentinel-2) to obtain information about land cover, environmental changes, and resource conditions. For natural resource booking, Sentinel-2's 10-meter resolution optical bands enable the verification of land cover classes (e.g., forest, water, agricultural) to ensure that a requested site complies with its designated zoning category. Simultaneously, Sentinel-1's C-band SAR imagery provides all-weather change detection, allowing the system to flag recent illegal encroachments or flood-affected areas before approving a booking. Unlike static GIS layers, these satellite products offer near-real-time ground truthing, which is essential for enforcing environmental compliance in resource allocation. Studies such as Zhou et al. (2024) and Zhou et al. (2025) [54], [55] only used basic location data or IoT, not remote sensing data. The authors have direct experience in managing Sentinel satellite data at Spectral Imaging Services, which provides an advantage in designing this component.[54], [55]

3) Interactive mapping: The capability to display resources on an interactive map that enables users to view availability, zoom, and click on resources for further information.

4) Zoning and location analysis: The capability to analyze resource locations based on zoning rules, spatial regulations, and environmental data to determine eligibility and booking optimization.

D. Main Research Gaps and Future Research Directions (RQ4)

Based on the analysis of the 16 reviewed articles, four main research gaps have been identified (Table V). These gaps not only indicate what remains under-researched but also open opportunities for future research. Of the four gaps, Gap 1 (satellite data integration) and Gap 2 (MCDM+GIS optimization model) are the most significant gaps that have not been addressed at all by the existing literature. However, merely listing these gaps is insufficient; understanding their underlying causes is critical for charting meaningful future work. The persistence of these gaps can be attributed to disciplinary silos—researchers in optimization, GIScience, and public administration rarely collaborate—as well as the technical complexity of operationalizing satellite imagery (which requires preprocessing pipelines) within transactional booking databases. The following analysis reframes each gap not as a simple omission, but as a multi-faceted design challenge involving data integration, algorithmic adaptation, and institutional readiness. These gaps are not mere omissions but reflect deeper challenges: disciplinary silos between optimization, GIScience, and public administration researchers, as well as the technical complexity of integrating satellite imagery preprocessing pipelines with transactional booking databases.

Gap 1: Satellite Data Integration. The most significant gap is the absence of intelligent booking systems that integrate satellite data (such as Sentinel-1 and Sentinel-2) into the decision-making process. This finding aligns with the research by Turner et al. [56], [57], which emphasizes that satellite data has great potential to support natural resource management, yet its integration into operational systems remains very limited. Future research can focus on developing architectures that enable booking systems to consume and process satellite data in real-time to improve decision accuracy.

Gap 2: MCDM + GIS Optimization Model. Although MCDM has been used in various fields such as tourism and education, its application to booking systems for natural resource and urban domains integrated with GIS remains very limited. Future research can focus on developing new optimization models that combine MCDM with GIS-based spatial analysis to solve complex resource allocation problems [58], [59].

Gap 3: Domain-Specific Component Guidance. Existing literature on booking system components is mostly generic or developed for other specific domains. Future research can develop a comprehensive and validated component framework for natural resource and urban development domains, which can serve as a guide for system developers in government agencies [60], [61].

Gap 4: Siloed Systems in Government Agencies. Most research on booking systems focuses on solutions for a single domain or specific organization. Future research can address integration across systems in government agencies, including data interoperability and business processes.

E. Research Implications

This SLR yields several important theoretical and practical implications. Theoretically, it bridges critical gaps in the existing body of knowledge by presenting an updated six-category classification framework for intelligent booking systems (IBS) components, highlighting geospatial integration as a notably absent architectural element, and delivering a systematic map of research voids. These contributions extend Babafemi et al.'s [62] foundational framework with contemporary categories driven by AI, optimization, and spatial technologies.

Practically, the proposed framework (Fig. 2) acts as a blueprint for developers at Malaysia's Ministry of Natural Resources and Urban Development, Sarawak, and other government agencies. It clarifies not only the necessary modules and their interconnections but also how geospatial data can be operationalized. However, technical architecture alone is insufficient; success depends on organizational readiness, digital-intelligent transformation [63], and generative AI adoption [64]. Furthermore, frameworks for AI social responsibility [65] and sustainable governance (e.g., CICC, 2022 [66]) offer essential benchmarks for designing systems that are efficient, socially responsible, and transparent, aligning with public sector values and the digitalization mandates for resource management [1], [2].

F. Research Limitations

This review is limited to English articles, excluding non-English research. The search, confined to IEEE Xplore, SpringerLink, ScienceDirect, and ACM Digital Library (representing core CS/IS/engineering outlets), may miss relevant works in Web of Science, Google Scholar, or regional databases; Scopus was deliberately excluded after scoping searches confirmed no additional eligible records. The 2021–2025 timeframe, justified by recent AI/GIS progress, excludes earlier foundational literature, though key advancements remain recent. Finally, despite a systematic protocol, subjectivity in screening and quality assessment was unavoidable, but minimized through documented traceability.

V. CONCLUSION

This section presents the conclusion of the research, the contributions made, as well as suggestions for future research. The conclusion is formulated based on the findings and discussion elaborated in the previous sections, while still referring to the research questions that have been established.

A. Conclusion

Guided by the established research questions, a comprehensive Systematic Literature Review (SLR) was conducted across four major databases—IEEE Xplore, SpringerLink, ScienceDirect, and ACM Digital Library—covering the 2021–2025 period. This rigorous process initially retrieved 40 articles, which were subsequently filtered through a strict eligibility and quality assessment protocol, resulting in 16 final articles selected for in-depth synthesis. Based on this analysis, four principal conclusions have been formulated.

First, the core components of intelligent booking systems (IBS) can be systematically classified into six distinct categories. These comprise Resource Management (identified in 12 articles), Booking Management (11 articles), Intelligence and AI/Optimization (10 articles), Geospatial Integration (4 articles), System Integration (8 articles), and Security and Compliance (5 articles). While the Resource and Booking Management categories constitute the essential functional foundation consistently found across the literature, the Intelligence and Geospatial Integration categories serve as the primary differentiators, elevating these systems from conventional transactional calendars to truly adaptive and predictive platforms.

Second, to effectively meet the specific requirements of natural resource and urban development domains, these generic IBS components require three critical modifications. Geospatial data must be treated as a mandatory attribute for every resource within the system. Additionally, zoning protection and eligibility rules must be embedded as core constraints in the scheduling logic. Finally, automatic location verification capabilities, based on geospatial datasets, must be enabled. These modifications are non-negotiable given the distinct spatial characteristics and stringent regulatory frameworks governing natural resources and urban facilities, which are absent in conventional domains like libraries or laboratories.

Third, successful integration of geospatial data into intelligent booking systems requires four essential architectural elements. These include a GIS interface to connect the system to map servers for spatial data rendering, integration of Sentinel-1 and Sentinel-2 satellite data to provide up-to-date land cover and environmental change information, interactive mapping features enabling users to view and select resources based on location, and comprehensive zoning/location analysis to verify eligibility against spatial and environmental regulations. The proposed component framework (Fig. 2) presents a holistic architecture that cohesively integrates these four elements.

Fourth, the review identifies four significant research gaps currently unaddressed in the literature:

- None of the studies use Sentinel-1/2 imagery for location verification or environmental monitoring, leaving a complete void.
- No models combine Multi-Criteria Decision Making with GIS-based spatial analysis for resource and urban facility allocation; existing studies treat them separately.
- Most articles are generic or narrowly focused (e.g., parking, EV charging), lacking frameworks tailored to natural resources and urban planning.
- Current research ignores interoperability and inter-departmental collaboration, focusing only on isolated organizational environments.

Among these four gaps, Gaps 1 and 2 are the most critical, as they remain entirely unexplored in the existing literature. Consequently, they offer the most substantial opportunities for future applied research, particularly for advancing sustainable and efficient natural resource management practices in Sarawak.

B. Implications and Contributions of the Research

Theoretically, this research delivers the first Systematic Literature Review (SLR) mapping the intersection of Intelligent Booking Systems (IBS), GIS, and natural resource/urban management. This study also produces a six-category classification framework, highlighting geospatial integration as a missing architectural element. This study also provides a systematic map of research gaps.

Practically, the proposed framework (Fig. 2) in this research serves as a blueprint for system developers at the Ministry of Natural Resources and Urban Development Sarawak and other Malaysian agencies. This study offers guidance on component relationships and geospatial implementation. Policy recommendations include digitizing manual booking systems, investing in spatial data and satellite integration, and building HR capacity in geospatial AI.

Methodologically, the SLR protocol, classification framework, and geospatial integration approach are replicable for IBS studies in other domains and public sector systems.

C. Limitations and Future Research Agenda

This review has several limitations that should be acknowledged. First, it is confined to English-language articles from IEEE Xplore, SpringerLink, ScienceDirect, and the ACM Digital Library. While these databases represent the core outlets in computer science, information systems, and engineering, relevant works published exclusively in Web of Science, Google Scholar, or regional/non-English journals may have been omitted. Scopus was deliberately excluded after scoping searches confirmed no additional unique eligible records beyond those already covered. Second, the 2021–2025 timeframe was chosen to capture recent advancements in AI, GIS, and optimization technologies; however, this decision intentionally excludes foundational pre-2021 literature that may provide relevant historical context. Third, despite the implementation of a systematic and documented protocol, inherent subjectivity in title/abstract screening and quality assessment scoring was unavoidable, though it was minimized through consensus-based decision-making and traceable records.

To address the identified gaps and advance the field, future research should pursue the following directions:

- Develop MCDM+GIS optimization models – Design and validate novel optimization frameworks that integrate Multi-Criteria Decision Making with GIS-based spatial analysis specifically for natural resource and urban facility allocation, addressing the complete void identified in Gap 2.
- Integrate Sentinel-1/2 satellite data – Operationalize near-real-time Sentinel-1 (SAR) and Sentinel-2 (optical) imagery within booking workflows to enable automated location verification, land cover classification, and environmental change detection, directly tackling Gap 1.
- Validate the proposed framework via case studies – Apply the component framework (Fig. 2) in real-world settings at the Ministry of Natural Resources and Urban Development Sarawak using Design Science Research (DSR) methodologies to assess its practicality, usability, and effectiveness.
- Prototype and test the integrated system – Build functional prototypes of the geospatially-enabled intelligent booking system and conduct empirical evaluations in live government environments to measure performance improvements in decision accuracy, resource utilization, and operational efficiency.
- Engage multi-stakeholder perspectives – Incorporate viewpoints from public agencies, private sector operators, NGOs, and local communities to ensure the resulting system is equitable, transparent, inclusive, and aligned with the Sustainable Development Goals (SDGs).

By systematically bridging these gaps—particularly satellite data integration and MCDM+GIS optimization—this research provides a solid foundation for developing smarter, more transparent, and sustainable resource governance systems in Sarawak, Malaysia, and other regions facing similar urbanization and natural resource management challenges.

REFERENCES

[1] L. Chandra Voumik, · Mahinur, B. Mimi, and A. Raihan, “Nexus Between Urbanization, Industrialization, Natural Resources Rent, and Anthropogenic Carbon Emissions in South Asia: CS-ARDL Approach,” Anthropocene Science 2023 2:1, vol. 2, no. 1, pp. 48–61, Mar. 2023, doi: 10.1007/S44177-023-00047-3.

[2] A. S. Mohd Ali, T. Masron, S. N. Junaini, A. Ahmad, and R. Soda, “Ethnic Disparities and Demographic Shifts in Sarawak’s Aging Population: A Comprehensive Longitudinal Analysis (1980-2020),” International Journal of Geoinformatics, vol. 21, no. 2, pp. 106–122, Feb. 2025, doi: 10.52939/ijg.v21i2.3943.

[3] Z. Zhang, X. Dong, H. Wang, Z. Zhang, and X. Lu, “Design of intelligent centralized reservation system based on mobile terminal,” https://doi.org/10.1117/12.2683019, vol. 12703, p. 524, Jun. 2023, doi: 10.1117/12.2683019.

[4] K. Kaur, T. Thanuja, O. Dahiya, P. T. Sai, H. Kaur, and J. Singh, “Design and Development of a Ticket Booking System using Smart Bot,” 2022 10th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions), ICRITO 2022, 2022, doi: 10.1109/ICRITO56286.2022.9964700.

[5] S. Zahedieh, A. Oulis Rousis, and A. Bourazeri, “Toward a unified framework for electric vehicle infrastructure: Insights into charging management, communication and emerging technologies,” Energy Reports, vol. 14, pp. 1834–1854, Dec. 2025, doi: 10.1016/J.EGYR.2025.08.011.

[6] Y. Zheng, D. Liu, F. An, J. Wang, X. Gao, and N. Jia, “Impact of charging infrastructure construction on electric vehicle diffusion based on a multi-agent model,” iScience, vol. 28, no. 4, p. 112257, Apr. 2025, doi: 10.1016/J.ISCI.2025.112257.

[7] X. Liu, P. Kortoçi, N. H. Motlagh, P. Nurmi, and S. Tarkoma, “A survey of COVID-19 in public transportation: Transmission risk, mitigation and prevention,” Multimodal Transportation, vol. 1, no. 3, p. 100030, Sep. 2022, doi: 10.1016/J.MULTRA.2022.100030.

[8] X. Tang, C. Sun, S. Bi, S. Wang, and A. Y. Zhang, “A holistic review on advanced bi-directional EV charging control algorithms,” ACM SIGEnergy Energy Informatics Review, vol. 1, no. 1, pp. 78–88, Nov. 2021, doi: 10.1145/3508467.3508474.

[9] E. Gümrükcü, A. Ahmadifar, A. Yavuzer, F. Ponci, and A. Monti, “datafev—A Python framework for development and testing of management algorithms for electric vehicle charging infrastructures,” Software Impacts, vol. 15, p. 100467, Mar. 2023, doi: 10.1016/J.SIMPA.2023.100467.

[10] S. Ben Hassine, E. Kooli, and R. Mraihi, “Real-Time Prediction of Off-Street Parking Spaces Based on Dynamic Resource Allocation and Pricing,” pp. 28–40, 2024, doi: 10.1007/978-3-031-52823-1_2.

[11] R. Ghani, E. Farjah, and M. R. Oboudi, “A mathematical model for the development of distributed energy storage devices in the V2V charging process systems based on fuzzy graph theory,” J. Energy Storage, vol. 110, p. 115269, Feb. 2025, doi: 10.1016/J.EST.2024.115269.

[12] S. Ray, K. Kasturi, and M. R. Nayak, “Multi-objective electric vehicle charge scheduling for photovoltaic and battery energy storage-based electric vehicle charging stations in distribution network,” Green Energy and Intelligent Transportation, vol. 4, no. 4, p. 100296, Aug. 2025, doi: 10.1016/J.GEITS.2025.100296.

[13] K. Balasubramanian and S. M. Rasoolimanesh, “The Progress of ICT Applications in Destination Marketing in Emerging Economies,” Palgrave Studies of Marketing in Emerging Economies, vol. Part F3551, pp. 167–186, 2022, doi: 10.1007/978-3-030-83711-2_8.

[14] S. Tehseen, E. Yafi, Z. H. Qureshi, and R. A. Rather, “Technology Application in the Asian Tourism Industry: Artificial Intelligence and Blockchain in Smart City Involvement,” Handbook of Technology Application in Tourism in Asia, pp. 493–505, Jan. 2022, doi: 10.1007/978-981-16-2210-6_23.

[15] K. Zhang and W. Cheng, “Artificial intelligence, big data and algorithms make it possible for stakeholders to build smart tourism destinations: take Tianzhu Mountain Scenic Area as an example,” ACM International Conference Proceedings Series, vol. 1, pp. 146–152, Oct. 2024, doi: 10.1145/3690407.3690432.

[16] M. Svitlana, K. Iryna, M. Stefaniia, S. Viktoriia, and N. Sergii, “Eco-Friendly Hospitality in the Digital Era: Trends, Technologies, and Transformations,” Communications in Computer and Information Science, vol. 2652 CCIS, pp. 3–28, 2025, doi: 10.1007/978-3-032-04228-6_1.

[17] M. R. Cosma, M. C. Türkeș, and A. F. Stăncioiu, “Changes in Consumer Behavior Through the Use of AI on Tourism Platforms in Disruptive Times,” Springer Proceedings in Business and Economics, pp. 700–713, 2026, doi: 10.1007/978-3-032-19276-9_45.

[18] C. H. Wu, M. T. Chou, and C. H. Liu, “Exploring consumer behavior and brand loyalty in recreational prawn fishing: The influence of experience, value, and innovation,” Mar. Policy, vol. 182, p. 106860, Dec. 2025, doi: 10.1016/J.MARPOL.2025.106860.

[19] H. C. Turner et al., “Extent, Severity, and Temporal Patterns of Damage to Cuba’s Ecosystems following Hurricane Irma: MODIS and Sentinel-2 Hurricane Disturbance Vegetation Anomaly (HDVA),” Remote Sensing 2023, Vol. 15, Page 2495, vol. 15, no. 10, p. 2495, May 2023, doi: 10.3390/RS15102495.

[20] D. Phiri, · Charles Mulenga, and V. R. Nyirenda, “Mapping flood extent of Cyclone Freddy using Sentinel-1 SAR data in Google Earth Engine in Southern Malawi,” Discover Water 2025 5:1, vol. 5, no. 1, pp. 12-, Feb. 2025, doi: 10.1007/S43832-025-00199-W.

[21] M. F. Goodchild, “Geography and the Information Society,” A Geographical Century: Essays for the Centenary of the International Geographical Union, pp. 225–234, Jan. 2022, doi: 10.1007/978-3-031-05419-8_16.

[22] A. Li, L. Niu, M. Pan, and Y. Chen, “Integrated analysis of urban multiple geospatial information based on GIS,” Proceedings - 2020 International Conference on Robots and Intelligent Systems, ICRIS 2020, pp. 422–425, Nov. 2020, doi: 10.1109/ICRIS52159.2020.00109.

[23] D. Reverberi, V. Kammerlohr, G. Esposito, A. S. Ghorpade, G. Romagnoli, and D. Uckelmann, “Billing and Booking System for Distributed IoT Laboratories,” Lecture Notes in Networks and Systems, vol. 524 LNNS, pp. 395–405, 2023, doi: 10.1007/978-3-031-17091-1_40.

[24] E. Qefalija, H. Snopce, and A. Dermaku, “Literature Review on Constraint Satisfaction Problems Solving,” ISMSIT 2024 - 8th International Symposium on Multidisciplinary Studies and Innovative Technologies, Proceedings, 2024, doi: 10.1109/ISMSIT63511.2024.10757207.

[25] R. Kumar and D. Pamucar, “A Comprehensive and Systematic Review of Multi-Criteria Decision-Making (MCDM) Methods to Solve Decision-Making Problems: Two Decades from 2004 to 2024,” Spectrum of Decision Making and Applications, vol. 2, no. 1, pp. 177–196, Jan. 2025, doi: 10.31181/SDMAP21202524.

[26] S. Lane and I. Richardson, “Process models for service-based applications: A systematic literature review,” Inf. Softw. Technol., vol. 53, no. 5, pp. 424–439, May 2011, doi: 10.1016/J.INFSOF.2010.12.005.

[27] M. J. Page et al., “The PRISMA 2020 statement: an updated guideline for reporting systematic reviews,” BMJ, vol. 372, Mar. 2021, doi: 10.1136/BMJ.N71.

[28] L. Sun and R. Song, “Smart Reservation and Sketch Timetabling Based on ADMM: A Dual-Decomposition Algorithm Application,” IEEE Access, vol. 9, pp. 81314–81325, 2021, doi: 10.1109/ACCESS.2021.3084938.

[29] Z. Sadreddini, S. Guner, and O. Erdinc, “Design of a Decision-Based Multicriteria Reservation System for the EV Parking Lot,” IEEE Transactions on Transportation Electrification, vol. 7, no. 4, pp. 2429–2438, Dec. 2021, doi: 10.1109/TTE.2021.3067953.

[30] A. A. Al-Khatib, M. U. Hassan, and K. Moessner, “Heuristic Optimization of Bandwidth Reservation Cost for Vehicular Applications,” Proceedings - IEEE Global Communications Conference, GLOBECOM, pp. 4909–4915, 2022, doi: 10.1109/GLOBECOM48099.2022.10001328.

[31] F. Muzzini, M. Montangero, and N. Capodieci, “Smart Parking for All: Equipped and Non-equipped Vehicles in Smart Cities,” Studies in Computational Intelligence, vol. 1089 SCI, pp. 257–266, 2023, doi: 10.1007/978-3-031-29104-3_28.

[32] L. P. Y. Ting, C. C. Lin, S. H. Lin, Y. L. Chu, and K. T. Chuang, “Multi-agent Reinforcement Learning for Online Placement of Mobile EV Charging Stations,” Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), vol. 14649 LNAI, pp. 284–296, 2024, doi: 10.1007/978-981-97-2262-4_23.

[33] X. Wang, “Research on the strategy of building a smart laboratory under the background of artificial intelligence,” Proceedings of the 2nd International Conference on Intelligent Education and Computer Technology, IECT 2025, vol. 1, pp. 150–156, Nov. 2025, doi: 10.1145/3764206.3764229.

[34] S. A. Zhou, “Multi-source data fusion analysis model for intelligent operation of stadiums,” Proceedings of 2024 International Conference on Sports Technology and Performance Analysis, ICSTPA 2024, vol. 1, pp. 346–352, May 2025, doi: 10.1145/3723936.3723989.

[35] S. S. Channamallu, S. Kermanshachi, J. M. Rosenberger, A. Pamidimukkala, and G. Hladik, “Urban parking challenges and solutions: a case study,” Transportation Research Procedia, vol. 93, pp. 859–865, Jan. 2026, doi: 10.1016/J.TRPRO.2025.12.015.

[36] R. Yadav, K. Chauhan, and R. K. Chauhan, “Charger fault rate analysis-based optimal electric vehicle charging station scheduling and routing framework,” J. Energy Storage, vol. 170, Aug. 2026, doi: 10.1016/j.est.2026.122674.

[37] Q. Lv, Z. Cui, L. Li, D. Liu, and L. Cui, “Intelligent Circular Stereo Garage: Space Efficiency Optimization and Intelligent Efficient Collaborative Control Based on PLC-IoT,” Lecture Notes in Electrical Engineering, vol. 1537 LNEE, pp. 25–38, 2026, doi: 10.1007/978-981-95-6322-7_3.

[38] W. Han and D. Wang, “New energy vehicle fast charging reservation algorithm based on Internet of Things coordination,” Discover Internet of Things 2025 5:1, vol. 5, no. 1, pp. 124-, Nov. 2025, doi: 10.1007/S43926-025-00212-7.

[39] Navpreet, R. Rani, and R. K. Roul, “State-of-the-Art Machine Learning and Deep Learning Techniques for Parking Space Classification: A Systematic Review,” Archives of Computational Methods in Engineering 2025 32:6, vol. 32, no. 6, pp. 3851–3883, Mar. 2025, doi: 10.1007/S11831-025-10250-7.

[40] M. R. Fatema, K. Naher, M. H. I. Rifat, and M. A. Babu, “Customer experience as a key mechanism linking AI chatbot attributes to booking

intention in tourism," Quality & Quantity 2026, pp. 1–29, Apr. 2026, doi: 10.1007/S11135-026-02800-3.

[41] X. (Simon) Zhou, T. Kim, M. Ameli, H. (Bety) Zhu, Y. Honma, and R. M. Pendyala, "Flow-through tensors: A unified computational graph architecture for multi-layer transportation network optimization," Artificial Intelligence for Transportation, vol. 1, p. 100006, Jul. 2025, doi: 10.1016/J.AIT.2025.100006.

[42] W. Zayat, H. S. Kilic, A. S. Yalcin, S. Zaim, and D. Delen, "Application of MADM methods in Industry 4.0: A literature review," Comput. Ind. Eng., vol. 177, p. 109075, Mar. 2023, doi: 10.1016/J.CIE.2023.109075.

[43] T. Gurung, S. Swami, R. Singh, S. Kumar, and N. Yamsani, "Smart Transportation Using Internet of Things (IoT)," Lecture Notes in Networks and Systems, vol. 1164 LNNS, pp. 883–891, 2025, doi: 10.1007/978-981-97-8329-8_64.

[44] B. Xu, Y. Shao, P. Yidilisi, and T. Yang, "Explaining donor lapse in voluntary blood donation: A grounded theory study from China," Soc. Sci. Med., vol. 403, Aug. 2026, doi: 10.1016/j.socscimed.2026.119420.

[45] V. Braun and V. Clarke, "Using thematic analysis in psychology," Qual. Res. Psychol., vol. 3, no. 2, pp. 77–101, 2006, doi: 10.1191/1478088706QP063OA.

[46] M. Allaymoun and S. Shorman, "AI-Powered Websites in e-commerce, Healthcare, Education," Studies in Systems, Decision and Control, vol. 524, pp. 319–329, 2024, doi: 10.1007/978-3-031-54379-1_28.

[47] M. Jami Pour, M. Hosseinzadeh, and M. Moradi, "IoT-based entrepreneurial opportunities in smart transportation: a multidimensional framework," International Journal of Entrepreneurial Behavior & Research, vol. 30, no. 23, pp. 450–481, May 2023, doi: 10.1108/IJEBR-06-2022-0574.

[48] A. Chakraborty and V. Jain, "Leveraging Digital Marketing and Integrated Marketing Communications for Brand Building in Emerging Markets," Palgrave Studies of Marketing in Emerging Economies, vol. Part F3553, pp. 281–305, 2022, doi: 10.1007/978-3-030-88678-3_13.

[49] M. Owonibi, E. Petzold, and B. Koenig-Ries, "Towards a generic resource booking management system," Lecture Notes in Business Information Processing, vol. 245, pp. 73–80, 2016, doi: 10.1007/978-3-319-32799-0_6.

[50] T. Zhang, L. Lu, O. H. Chi, C. Lu, and C. Cobanoglu, "Smart Service Interactional Experience for Family Travelers: Scale Development and Validation," Journal of Hospitality and Tourism Research, vol. 49, no. 4, pp. 667–687, May 2025, doi: 10.1177/10963480231226085.

[51] V. Hensel and K. Lemke-Rust, "On an integration of an information security management system into an enterprise architecture," Proceedings - 21st International Workshop on Database and Expert Systems Applications, DEXA 2010, pp. 354–358, 2010, doi: 10.1109/DEXA.2010.75.

[52] A. Ali, M. Ahmad, M. Nawaz, and F. Sattar, "Spatial data infrastructure as the means to assemble geographic information necessary for effective agricultural policies in Pakistan," Information Development, Jun. 2024, doi: 10.1177/02666669241244503.

[53] E. Congiu, G. Desogus, C. Frau, G. Gatto, and S. Pili, "Web-Based Management of Public Buildings: A Workflow Based on Integration of BIM and IoT Sensors with a Web–GIS Portal," Buildings 2023, Vol. 13, Page 1327, vol. 13, no. 5, p. 1327, May 2023, doi: 10.3390/BUILDINGS13051327.

[54] X. Zhou et al., "Flow-Through Tensors: A Unified Computational Graph Architecture for Multi-Layer Transportation Network Optimization," Jun. 2025, Accessed: Jul. 20, 2026. [Online]. Available: https://arxiv.org/pdf/2507.02961

[55] G. Anushree, V. Prema K, and N. Pavithra, "AI-Driven Precision Agriculture: Analysing Its Impact on Crop Yield, Sustainability, and Farm Efficiency," 2025 5th Asian Conference on Innovation in Technology, ASIANCON 2025, 2025, doi: 10.1109/ASIANCON66527.2025.11281117.

[56] A. J. Turner et al., "A large increase in U.S. methane emissions over the past decade inferred from satellite data and surface observations," Geophys. Res. Lett., vol. 43, no. 5, pp. 2218–2224, Mar. 2016, doi: 10.1002/2016GL067987.

[57] W. Turner et al., "Free and open-access satellite data are key to biodiversity conservation," Biol. Conserv., vol. 182, pp. 173–176, Feb. 2015, doi: 10.1016/J.BIOCON.2014.11.048.

[58] R. E. Yildirim and A. Sisman, "Spatial Decision Support for Determining Suitable Emergency Assembly Places Using GIS and MCDM Techniques," Sustainability 2025, Vol. 17, Page 2144, vol. 17, no. 5, p. 2144, Mar. 2025, doi: 10.3390/SU17052144.

[59] M. Başeğmez, A. Doğan, and C. C. Aydın, "Management of sustainable urban green spaces through machine learning–supported MCDM and GIS integration," Environmental Science and Pollution Research 2025 32:18, vol. 32, no. 18, pp. 11466–11487, Apr. 2025, doi: 10.1007/S11356-025-36367-7.

[60] X. Deng et al., "An Analytical Framework on Utilizing Natural Resources and Promoting Urban–Rural Development for Increasing Farmers' Income Through Industrial Development in Rural China," Front. Environ. Sci., vol. 10, p. 865883, Apr. 2022, doi: 10.3389/FENVS.2022.865883/TEXT.

[61] R. Zakariya, M. Shehata, and H. Hafez, "A Framework for National Urban Policy-Making Evaluation Methodology: Challenges of Natural Resources Sustainability in Egypt," Civil Engineering and Architecture, vol. 10, no. 5A, pp. 158–175, 2022, doi: 10.13189/cea.2022.101408.

[62] O. P. Babafemi, T. F. Ajani, M. O. Binuyo, A. O. Ajagbe, S. K. Owonibi, and M. C. Ogwu, "Biomonitoring for Sustainable Development," Biomonitoring of Pollutants in the Global South, pp. 191–239, Jan. 2024, doi: 10.1007/978-981-97-1658-6_6.

[63] P. Wang, Y. Hu, N. Wei, and X. Wu, "Dual pathways for high-quality development: The role of cultural tourism integration and digital-intelligent transformation in Chinese tourism enterprises," International Review of Financial Analysis, vol. 110, p. 104867, Feb. 2026, doi: 10.1016/J.IRFA.2025.104867.

[64] T. Kan and E. C. S. Ku, "Expert knowledge: collaborating with generative artificial intelligence to improve service innovation performance," Asia Pacific Journal of Marketing and Logistics, vol. 38, no. 5, pp. 1257–1276, May 2026, doi: 10.1108/APJML-01-2025-0159.

[65] P. Shen, D. Peng, Y. Chen, and J. Xu, "The impact of AI social responsibility on service loyalty: a mixed-method approach," Technol. Soc., vol. 87, p. 103375, Aug. 2026, doi: 10.1016/J.TECHSOC.2026.103375.

[66] CICC Research and CICC Global Institute, "Living Green: New Chapter of Consumption and Social Governance," Guidebook to Carbon Neutrality in China, pp. 205–233, 2022, doi: 10.1007/978-981-16-9024-2_9.