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A Qualitative Analysis of AI-Driven Social Monitoring and Regulatory Compliance at Van Vihar National Park, Bhopal

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Abstract

This paper will discuss the adoption of Artificial Intelligence (AI) as a Digital Guardian towards social sustainability in Van Vihar National Park, Bhopal. To ensure the quality of the environment and welfare of animals, traditional reactive enforcement is ineffective faced with high levels of human-wildlife interface pressures. The research assesses the real-time surveillance technologies, such as automated crowd counting and intelligent surveillance through interviews with park managers, foresters, and developers. The results indicate that although AI can greatly improve visitor safety and social responsibility, which correlates with the international standards of ESG, ethical issues related to surveillance and the digital divide emerge. The paper wraps up by finding that AI monitoring needs to be accompanied with Smart Storytelling to transform surveillance into a means of environmental education. The stakeholders can be able to scale the models of sustainable tourism that safeguard urban-ecological systems with the necessary social justice. It is a strategy to make AI not only a monitoring tool, but a driver of transparent, traceable, and ethical conservation.

Keywords: Smart City, AI-Driven Monitoring, Van Vihar National Park, ESG Framework, Urban Tourism Management.

1.0 Introduction

The geographical proximity of growing cities and green areas results in a special zone that is high-pressure and unique. It is called the Urban-Wilderness Interface. One of the most critical examples of this interface in India is Van Vihar National Park located in the very centre of Bhopal, Madhya Pradesh (Vajiram and Ravi, 2025). The park covers an area of the upper lake (Bhoj Wetland) a designated Ramsar Site over the banks of the lake and at the same time it is a home to a wide variety of avian and mammalian species. As opposed to isolated tiger reserves, Van Vihar is an open zoo and a national park that is under continuous anthropogenic stress due to its accessibility and high human traffic, and whose management is an intricate activity of balancing human recreation with wildlife conservation (Rane et al., 2023). Historically, visitor control in Van Vihar has been dependent on traditional, reactive policing.

This model relies on manual patrols of forest guards, and the reactive steps after a violation (littering, noise pollution, and animal harassment) has been committed(Popescu et al., 2024). Nevertheless, in a mass tourism world of fast urbanization, this human-based strategy is becoming less and less satisfactory. The shift to AI-Integrated (Pro-active) Monitoring is a paradigm shift. Through real-time information gathered through automated surveillance systems, crowd analytics and acoustic sensors, management can shift their approach to be more of a responding factor in situations instead of a preventing factor (Ali et al., 2025). By actively overseeing the crowd, it is possible to identify spikes in crowd density or behavioural deviations as they occur and enact intervention based on the data, preventing the need to rely on a person to respond to the situation (Rane et al., 2023).

Although the Van Vihar-Bhoj Wetland complex is ecologically important, there are major management disjuncture in ensuring Social Sustainability. The existing governance frameworks are unable to measure the Social (S) and Governance (G) parameter of the ESG framework especially on the compliance of behaviour of

the visitors (Clem Tisdell, 2012). The problems associated with high noise levels of urban tourists, feeding of animals, and dumping of waste in the wetland periphery cannot be addressed using manual monitoring due to the lack of 24/7 coverage and real time reporting that is objective (Nair, 2001).

In the absence of an open, technology-intensive mechanism to guarantee adherence, the park suffers a Sustainability Deficit in which the social usefulness of the park threatens to compromise its core conservation principle. Simbi Labs India is a multi-disciplinary research and consulting firm that provides detailed technical backing to academic and industrial research in statistical model building areas for providing inferences based on data (Simbi Labs, 2026b). The organization provides comprehensive assistance for doctoral and research professionals, using advanced tools like IBM SPSS, AMOS, Stata, and R to conduct complex multivariate analyses, including Structural Equation Modelling (SEM) and factor analysis (Simbi Labs, 2026a). Beyond academic rigor and publication-ready data interpretation, Simbi Labs has a regional presence in Bhopal, supporting local research through GIS surveys, voluminous primary data gathering, and niche environmental and tourism consultancy. The firm combines technological expertise with scientific methodology to aid in high-quality, scientifically backed research results in various fields (Simbi Labs, 2026b).

1.1 Objectives of the study

This study will be confined to a qualitative study of Van Vihar National Park interconnected with the hoj Wetland interface with a specific reference to the Social (S) and Governance (G) aspects of sustainability as mediated by AI technology (A. Kumar et al., 2025).

- To examine the effects of the shift in the focus of the conservation of urban-wilderness interface as Van Vihar on the management of the latter.
- To understand whether visitor adherence to codes of ethical/legal conduct (Social Compliance) a direct driver to the long-term Social Sustainability of the Bhoj Wetland is.
- The aim of the research was to explore the effectiveness of Computer Vision (CV) and Acoustic Monitoring in identifying non-compliant behaviour and supplying proactive and predictive data to park management.
- To come up with a methodology of using AI-generated data to meet the requirements of GRI 304 (Biodiversity) and GRI 413 (Local Communities) reporting principles and thereby increase the international funding opportunities and social trust.

2.0 Literature Review

2.1 International trends in AI in environmental monitoring and conservation of wildlife

The use of Artificial Intelligence (AI) in conservation has progressed beyond pilot projects to a level of Operational Maturity. Newer literature (2024-2026) places a major emphasis on the use of Deep Learning models to handle the large volumes of remote-sensing and on-ground IoT-generated data (Abby Hehmeyer, 2025). Wildlife Insights and Species Net have democratized conservation by enabling researchers to upload and analyze call centres of camera-trap images in minutes, detecting thousands of species with an accuracy of more than 90% (Madhuri Karad et al., 2026).

Moreover, recent studies point to the emergence of acoustic monitoring as a non-invasive instrument of monitoring ecosystem health. Now AI models can differentiate anthropogenic noises, including illegal chainsaw use or gunshots, and the unique vocalizations of endangered avian or mammalian species (Jessica Obianuju Ojadi et al., 2025). Although these trends are known as animal-centric, which have transformed the world of anti-poaching and population tracking, the literature has shown that the main focus is an ecological data (the E in ESG), and they do not pay much attention to the complexity of human behavioural interactions in such areas.

2.2 History of Smart City Infrastructure and its Expansion to Natural Spaces

The idea of the Smart City, characterized by its Integrated Command and Control Centres (ICCC), is no longer limited to traffic control or solid wastes collection. Studies show that there is a rising tendency of smart

ecology whereby urban infrastructure is expanded to Green Havens such as Van Vihar National Park (Bhopal Smart City Mission, 2025). Literature on smart cities (Abuga & Raghava, 2021) highlights that IoT devices created by AI and initially developed to fulfil the purpose of Public Safety and Mobility are reused to track social compliance in urban parks (Verma, 2026.).

Recent reports indicate that city-wide surveillance coupled with management of the park offers high-speed connectivity and data processing capability needed in real-time social monitoring (Abby Hehmeyer, 2025). With a National Park being regarded as a valuable, high-security urban resource, administrators can use already existing models of smart city development to monitor the degree of visitors and behavioural deviations. Nevertheless, researchers caution that such integration should be carefully handled to prevent the further increase of social inequalities and building a digital fence that would isolate the local population (Ziosi et al., 2024).

2.3 The "Social Gap" in Technology: Lack of Human-Centric AI Studies

Most studies of AI in protected regions overlook the social interaction of legal tourists, only measuring stress or threat of poaching among animals. The research on the effects of AI-driven monitoring on visitor psychology and behavioural compliance is deficient (GOI, 2026). According to the recent scoping reviews (PMC, 2025), although noise pollution is deemed the second most important environmental risk to health, a very limited number of studies focus on how the noise pollution affects visitor experience and compliance when monitored using AI-controlled Silent Zones (ICSSR, 2025).

Moreover, the article on *The Ethics of AI Surveillance* in 2026 describe a threat of the so-called digital panopticon that is the inability to relax in the wild, as there is a constant chance that someone is spying on them, and it might cause the loss of the restorative, psychologically significant value of the wilderness (Kumar, 2026). The study of what should be called Indigenous Sustainability (UNESCO, 2026) stresses that, to be effective, AI must be collaborative and human-centric so that non-tech-savvy visitors or local communities such as the Baigan tribe should not be left behind in the benefits of conservation. This absence of human-centric AI studies is recognized as a key obstacle in the attainment of genuine Social Sustainability in the safeguarded regions, in this research (Mohanty, 2024).

3.0 Methodology

3.1 Case Study Profile Van Vihar National Park (Physical and Regulatory Landscape)

The study focus is the Van Vihar National Park, a special conservation site, which is an Ex-situ site located in Bhopal, Madhya Pradesh. It is located on 4.45 sq. km, in between the crowded urban sprawl of Bhopal and the ecologically sensitive, Bhoj Wetland (Upper Lake).

- **Physical Landscape:** The park is an open zoo with large, almost natural enclosures, where animals are kept. Its distinctive linear geography, one road which intermingles the lake and the enclosures, provides a high-density zone of social pressure where tourists, morning walkers and wildlife are in close contact.
- **Regulatory Environment:** It being a National Park with the Wildlife Protection Act (1972) and a component of a Ramsar Site, there are stringent noise, waste, and entry controls. The park is also the most recent addition to adopt AI-controlled surveillance (controlled through Simbi Labs) to check the crowd density and perimeter security, which makes it the best laboratory to study digital social compliance.

3.2 Qualitative Triangulation: Reasoning behind 5-3-2-20 Stakeholder Sampling

This study uses Methodological Triangulation with Purposive Sampling strategy to ensure that the findings is not one-dimensional. The 30 participants used in the study were divided into four separate groups to ensure the 360-degree perspective of the social impact of AI:

Table 1: Qualitative Triangulation

Stakeholder Group	Sample Size (n)	ESG / Research Pillar	Core Research Objective
Park Administrators	05	Governance (G)	Analysing policy frameworks and the impact of AI on administrative decision-making.
Naturalists	03	Environmental (E)	Assessing the correlation between human noise levels, AI monitoring, and resident wildlife stress.
Technology Providers (Simbi Labs)	02	Technical Feasibility	Validating the operational constraints and capabilities of real-time monitoring hardware.
Frequent Visitors	20	Social (S)	Evaluating behavioural changes and psychological perceptions regarding digital privacy and surveillance.
Total Participants	30		

Source[1]: Author

This 5-3-2-20 division makes sure that the voice of the "Technical" side of the AI creators is matched with the voice of the “Human” and the voice of “The Regulatory” sides of the visitors and the state.

3.3 Data Gathering Tools: Qualitative Surveys and Semi-Structured Interviews

Two main instruments were used in the research and were developed de novo to fit the ESG Framework:

Table 2: Data Collection

Data Collection Method	Target Group / Setting	Instruments & Timing	Core Research Objective
Semi-Structured Interviews	Experts (Administrators, Naturalists, and Tech Providers)	10 open-ended questions designed to facilitate non-scripted dialogue.	Evaluating institutional preparedness, the accuracy of real-time alerts, and the ethical dilemma of "Smart" vs. "Wild" spaces.
Qualitative Surveys	Park Visitors	Descriptive questionnaires focused on narrative responses (e.g., behaviour in front of cameras).	Gathering "thick descriptions" of human psychology and behavioural shifts within an AI-monitored setting.
Field Observations	Van Vihar National Park (On-site)	Non-participant observations conducted during peak hours (Sundays).	Cross-referencing AI dashboard social compliance data with real-time visitor interactions and adherence to park rules.

Source[2]: Author

3.4 Thematic Analysis Process (Braun & Clarke)

Thematic Analysis framework suggested by Braun and Clarke (2006), was used to process the qualitative data. This is a strict approach, which makes sure that the results are based on data and not researcher bias:

Table 3: Thematic Analysis Process - Braun & Clarke

Study Section	Core Concept	Operational Variable	Strategic Outcome
ESG Framework	Multidimensional Governance	Shifting focus from "E" (Biological) to Social (S) and Governance (G) pillars.	Enhanced transparency and ethical, data-driven decision-making procedures.

Social Sustainability	Social Compliance	Visitor adherence to ethical/legal codes (e.g., Silent Zones, waste disposal).	Transformation of sustainability goals into concrete, measurable compliance data.
Digital Guardian	Autonomous Surveillance	Use of Computer Vision (CV) and Acoustic Monitoring for non-intrusive patrolling.	Proactive interception of perimeter breaches and noise violations to maintain ecosystem sanctity.
Biodiversity & Community	GRI Standards Alignment	Impact measurement using GRI 304 (Biodiversity) and GRI 413 (Local Communities).	Verified ESG reporting crucial for securing international conservation funding and social trust.

Source[3]*: https://doi.org/10.1145/3313831.3376401, https://www.globalreporting.org/standards/*

4. Results & Analysis

The data gathered by the 30 stakeholders was then thematically analyzed to identify four important dimensions of AI integration at Van Vihar National Park. These results show how the Passive Park can be turned into an active ESG-monitored zone.

4.1 Real-Time Intervention: AI Effective in Reducing Human-Wildlife Conflict

Simbi Labs technical interviews and park administrators assure that AI has greatly decreased the Response Gap. (Frida, 2026)

- **The Finding:** In the past, the breaches of perimeters (visitors crossing barriers or making illegal entries at night) were detected solely by manual patrols. The Computer Vision system, powered by AI, now gives real-time alerts to the control room. (Wolf et al., 2019)
- **Effectiveness:** Administrators indicated that there was a 40 percent decrease in physical boundary violation in the zones that were monitored. The AI is a kind of a virtual fence that recognizes movement patterns that may indicate that a visitor is trying to become excessively close to the animal fences (e.g., the tiger or sloth bear paddocks). (UN Tourism, 2024)
- **The "Conflict" Shift:** The "conflict" is solved on the digital level, by not allowing human access to sensitive wildlife areas, both animals and humans are spared stress and possible harm.

4.2 Acoustic Monitoring: The use of AI in regulating noise pollution

The naturalists and administrators identified noise as the most common social violation at Van Vihar.

- **Finding:** The length and behaviour of traditional Silent Zone signs were observed to be mostly overlooked. With the integration of acoustic sensors powered by AI, it is possible to map the Noise Heatmaps in the park. (Kumar, 2026)
- **The Mechanism:** Once the noise exceeds a certain level of decibel (e.g. loud music or screaming around the wetland), the system records the event.
- **Strategic Alleviation:** Strategic analysis reveals that real-time data could enable guards to be put in the Noisy Hotspots specifically, instead of walking around silent empty space. Naturalists found that bird populations around the Bhoj Wetland exhibited less of the behaviour of flushing (sudden flight by noise) in those places where AI-imposed noise compliance was well implemented. (Arthur Rylah Institute, 2026)

4.3 Visitor Perceptions: Safety, Surveillance and Privacy

The qualitative survey of 20 regular visitors showed a multifaceted psychological terrain about the Digital Guardian.

- **The "Safety-Compliance" Connection:** 85 percent of the visitors said they believed they were safer because AI was patrolling the park, specifically at the areas with isolated parts of the road. (Hajder et al., 2025)
- **The Privacy Paradox:** As much as the visitors were happy with the security, some of the visitors expressed that they were tired of the surveillance (Surveillance Fatigue), and that excessive visible cameras could ruin the wildness of the park.
- **Behavioural Modification:** The most important discovery was the Panopticon Effect, visitors confessed to being more inclined to place trash in the right containers or to speak more quietly when they could see a digital screen or a camera, even without a physical guard present. This demonstrates that AI is a very strong means of Social Compliance (Sinay Maritime Data Solution, 2024).

4.4 Institutional Readiness: The ability of Park Administrators to embrace AI Dashboards

The interviews with 05 Administrators covered the Governance (G) aspect of the ESG.

- **Technical Gap:** Although the interest in AI is great, there is a moderate Skills Gap. Administrators indicated that the AI is gathering tremendous amounts of data, but the existing staffing requires specialized training to understand "Predictive Analytics" (e.g., what Sunday will have the most crowd pressure) (Maidullah et al., 2024).
- **Governance Transparency:** The potential of unfiltered reporting is one of the key outcomes. Administrators mentioned that AI dashboards eliminate the possibility of manual log tampering and that the reports on the number of visitors and violations reported to the State Forest Department are completely accurate.
- **The Verdict:** The institution is "Strategically Ready" but "Operationally Maturing." The conversion will need a special Digital Cell in the park management to process the data flow between Simbi Labs and the forest guards (Kishnani & Sharma, 2022).

05. Discussion

5.1 Digital Divide: The dangers of being left out by Non-Tech-Savvy visitors

Although implementation of AI at Van Vihar will lead to increased efficiency in the operations, it will also create the risk of a Digital Divide. Within the framework of a city park in Bhopal, there are visitors who are technologically inclined young people and old people who walk in the morning and those who are on a visit. As the discussion shows, such a dependence on digital interfaces, including the use of QR-codes to respond to a feedback or app-based notifications, may be counterproductive to a large demographic (Gross et al., 2023). The AI has to be an invisible participant in the background to be able to promote social sustainability. The findings indicate that "Real-Time Monitoring" is not supposed to replace human interaction but should be used as an empowerment of forest guards so they can offer improved services to individuals that are not technologically connected to the world so that the park can continue being an inclusive environment to all people, technical literacy or not (Kara & Mkwizu, 2020).

5.2 AI Surveillance in Wild Space Ethical Implications

The conversion of Van Vihar into a Smart Park poses a philosophical question of whether or not constant surveillance will reduce the wildness of a National Park? This paper outlines a conflict between safety and serenity. Although AI cameras are important to social compliance and anti-poaching, they threaten the development of a digital panopticon in which the psychological healing power of nature is reduced due to the sense of being watched. The park has to find a balance ethically, making sure that surveillance is context aware. This implies that the cameras are to be placed to observe limits and High-Stress areas (such as the Upper Lake

promenade) instead of the deep forest observational areas and retain the sense of wilderness that is the number one attraction of urban visitors (Birrell et al., 2022).

5.3 Incorporating Real-Time Data in Governance (G) and Policy Transparency

The increase of Governance (G) is one of the most significant effects of AI that have been found in this study. Traditional management is also prone to Information Asymmetry whereby information regarding visitor violations or noise levels is not always reported. Evidence-based governance can be achieved by integrating the real-time dashboards of Simbi Labs into the official policy framework (John, 2025).

- **Transparency:** AI records can offer an unchanging digital audit trail of compliance violations. Policy Shift: This information can have a direct impact on the policy, including setting entry fees dynamically according to the crowd density in real time or proclaiming an Instant silent zone when AI sensors detect wildlife stress. This shifts the park to a strict, manual style of management to a dynamic, data-driven style of governance (Garefalakis et al., 2026).

5.4 ESG Materiality Matrix Proposal of Van Vihar

Based on the results of the 30-stakeholder analysis, this study proposes an ESG Materiality Matrix. This tool prioritizes the issues according to the weight they have on the stakeholders as compared to their effect on the sustainability of the park. As pointed out in the discussion, to Van Vihar, AI is not a technical upgrade, but rather the re-negotiation of the social contract between the city and the wild. The ESG framework enables the park to defend its budgets not only based on ticket sales, but also on its social compliance score, and its role in making Bhopal a smart and sustainable city (Matsali et al., 2025).

6.0 Conclusion & Future Recommendations

6.1 AI adoption in Urban National Parks strategic plan

The incorporation of Artificial Intelligence into the control of Van Vihar and the Bhoj Wetland is not only a technological enhancement, but a tactical requirement. A roadmap is suggested to scale this model into three phases:

- **Phase I: The "Silent Sentinel" (0–6 Months):** Consider installing non-invasive Acoustic Sensors and Computer Vision at high-traffic areas (e.g., the main entry gates and lakeside promenade) to create the baseline of Social Compliance data.
- **Phase II: Data-Driven Governance (6 18 Months):** Incorporation of real-time dashboards into the Integrated Command and Control Centre (ICCC) of Bhopal Smart City. This enables automatic Crowd Alerts and real time resource assignment of forest guards.
- **Phase III: The Interactive Ecosystem (18+ Months):** The use of AI data to give real-time visitors (through digital signage) the so-called sustainability feedback to encourage them to self-regulate noise and waste behaviour.

6.2 Conclusion on what has been done towards achieving social sustainability

The article enriches the discussion on social sustainability through the fact that Artificial Intelligence can go beyond the practice of animal counting and be used in the exercise of human management.

- **Behavioural Compliance:** The paper demonstrates that AI is used as a digital guardian, which establishes a mental atmosphere in which guests are more willing to follow park regulations, which minimizes the Anthropogenic Stress of the wildlife.

- **Governance Transparency:** AI satisfies the governance pillar of ESG because it makes the management of the park answerable to society and environmental authorities through unchanging, real-time records.
- **Urban-Wilderness Harmony:** The study indicates that technology can enable the coexistence of a high-density urban population and a sensitive Ramsar site without the deterioration of the social or ecological fabric of the area.

6.3 Study limitations and Future research directions

Although this study is rich in thick descriptions of the social landscape, it has its limitations; Having 30 stakeholders, the results are very much context-specific to Bhopal and Van Vihar. They provide Thematic Depth but cannot be statistically inferred to all national parks in India. The research is premised on the existing capabilities of technology such as Simbi Labs. With the development of AI to the edge computing and predictive behaviour modelling, the social dynamics can change.

6.4 Future Research Directions:

Future research should attempt to scale and measure the Panopticon effect quantitatively, in various age and income groups, through a Quantitative Survey. It is not yet understood how long-term the effects of "Digital Compliance" are, whether it is a few years or visitors get used to the surveillance over time after the novelty wears off. A Control Group of comparing AI-controlled parks such as Van Vihar with strictly manually controlled reserves (e.g., Satpura or Kanha) would give an idea of the real AI-effectiveness.

The paper concludes that the "Smart National Park" is not a paradox, but a Social Requirement of the 21 st century. With an AI-based ESG framework, Van Vihar can evolve into not a local park reactively but a global model of urban-wilderness management and prove that technology is the final solution between Smart Cities and Wild Spaces

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