Exploring the Potential of Artificial Intelligence for Sustainable Business Development in the Hotel Industry: A Post-Pandemic Analysis of Chiang Mai, Thailand

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The hotel industry has been significantly impacted by the COVID-19 pandemic, leading to changes in guest behaviour and hotel operations. Adopting artificial intelligence (AI) technologies has become increasingly popular to improve efficiency, sustainability, and the overall guest experience. This review article focuses on implementing AI in the post-pandemic context of Chiang Mai, Thailand, to develop a sustainable business model that reduces energy consumption and improves resource management. More specifically, hotels in Chiang Mai which depended mostly on international tourists before the pandemic, have had to adapt their ways of working and include new technology to make the area more appealing to guests. The research analyses the opportunities and challenges of AI adoption in the hotel industry, drawing from successful examples of AI implementation in the hotel industry. The study also explores the potential for sustainable business development in Chiang Mai using AI, highlighting the importance of considering local values and engaging with the community to promote responsible tourism practices. Although there may be initial investment costs and challenges associated with changing consumer behaviour, adopting a sustainable business model incorporating AI can lead to long-term benefits for both the environment and the hotel industry. Using AI for energy management, waste reduction, and personalised guest experiences can improve efficiency, reduce costs, and enhance the overall guest experience. By embracing AI technologies and sustainable practices, the hotel industry can adapt to the post-pandemic context and contribute to a more sustainable future.

Keywords: Sustainability/ Hotel/ COVID-19/ Artificial Intelligence/ Chiang Mai

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Introduction

Artificial intelligence (AI) has the potential to significantly enhance sustainability in the hotel industry, both by reducing energy consumption and by improving resource management. One way AI can help with sustainability in the hotel industry is by optimising hotel energy use (Chuan et al., 2024). For example, AI algorithms can monitor energy consumption patterns and identify areas where energy use can be reduced. They can adjust lighting, heating, and cooling systems automatically to minimise energy consumption while maintaining guest comfort. In addition to energy conservation, AI can help hotels manage their waste more efficiently. For example, AI can help hotels sort and recycle waste more effectively, reducing waste sent to landfills (Szczepaniuk & Szczepaniuk, 2023).

The hotel industry in Chiang Mai suffered a major decrease in tourist visitors and occupancy soon after COVID-19 spread. According to the publication, hotel revenue in Chiang Mai dropped by 75% in 2020 (Tourism Authority of Thailand, 2020). Because of this, hotels in the region are, now, integrating digital facilities and launching green initiatives to appeal to local people and follow the new health and environmental regulations (Chiang Mai Citylife, 2020).

Another area where AI can make a significant impact is in water conservation. AI can monitor water usage in hotels, identifying areas where water is wasted and recommending reducing consumption. AI can also help hotels optimise their water treatment processes, reducing the amount of water wasted during treatment. Finally, AI can help hotels personalise their guest experience in a way that also reduces waste. For example, by analysing guest preferences and behaviour patterns, hotels can better anticipate and provide the services and amenities their guests will appreciate while avoiding unnecessary waste from offering amenities that guests are unlikely to use. According to Booking.com (2020), 82% of tourists in Thailand are now more concerned about green travel which is why hotels in Chiang Mai should quickly adapt their business practices. These artificial intelligence programs have proven that they can directly help hotels save energy and resources which in turn helps reduce their carbon footprint (Sustainability Times, 2019). Thus, using AI in Chiang Mai, Thailand's hotel sector, can be a valuable tool for promoting sustainability by effectively managing resources and minimising wastage; it can ensure guests have a pleasant and eco-friendly experience during their stay (Debnath et al., 2024; Rhallab, 2024).

Opportunities and Concerns Regarding AI in the Sustainable Hotel Industry

Kim and Lee (2018) highlight the potential of AI to enhance the tourism experience, particularly in the areas of personalised recommendations and virtual assistants. By analysing large volumes of consumer preferences and behaviour data, AI algorithms can generate tailored recommendations for travellers, improving their overall experience. Additionally, AI-powered virtual assistants can provide 24/7 customer service and support, enhancing responsiveness and reducing the need for human staff. Tussyadiah and Park (2018) explore the potential benefits of hotel service robots which AI can power. These robots can perform various tasks, from providing information to guests to cleaning rooms and delivering room service. By automating these tasks, hotels can reduce labour costs and increase efficiency while giving guests a novel and engaging experience.

According to Sigala (2020), the COVID-19 pandemic has severely affected the tourism industry and requires innovative solutions for recovery and future development. One such solution is AI, which can enhance the flexibility and responsiveness of tourism products and services. Additionally, AI can aid in implementing new health and safety protocols by enabling chatbots to screen guests for COVID-19 symptoms and offer appropriate guidance. Overall, these studies suggest that AI has the potential to bring significant benefits to the hotel industry, from enhancing the guest experience to improving efficiency and reducing costs. However, it is essential to note that there may be challenges associated with implementing AI, such as ensuring data privacy and security and managing the impact on human workers. Therefore, careful planning and consideration are needed to ensure that the benefits of AI are maximised and any potential drawbacks are minimised. Artificial intelligence (AI) is a powerful tool that can be applied to various problems in the hotel industry, including sustainability. Using AI algorithms and machine learning techniques, hotels can optimise their energy consumption, reduce waste, water conservation and provide a more personalised guest experience. Here are some specific ways that AI can help promote sustainable hotel:

Energy conservation

Payne and Rawlins (2019) discuss the potential of AI to help hotels reduce their energy consumption, focusing on occupancy sensors, machine learning algorithms, and other AI tools. Therefore, AI can help hotels monitor and reduce their energy consumption in several ways. One approach is to install occupancy sensors in hotel rooms, which can detect when guests are present and automatically adjust the lighting, heating, and cooling systems accordingly.

Nguyen et al. (2020) present a summary of the status of research on occupancy-based energy management in hotels, including the use of occupancy sensors, smart thermostats, and other AI tools. Which discussed by adapting AI tools in hotel management not only saves energy but also improves guest comfort by ensuring that rooms are not too hot or too cold. Another approach is using machine learning algorithms to analyse data on energy usage patterns, identifying areas where energy is wasted and making recommendations for improvement. For example, hotels can use this data to identify rooms or areas that use more energy than others and then take steps to optimise energy usage in those areas. By optimising energy usage in this way, hotels can reduce their carbon footprint and save money on their utility bills.

Waste management

Singhal et al. (2020) review the literature on innovative and sustainable waste management in hotels, including using computer vision, machine learning, and other AI tools to optimise waste sorting and recycling. Therefore, AI can help hotels manage their waste more effectively, reducing waste in landfills. One approach is to use computer vision technology to sort and recycle waste more efficiently. For example, cameras can be installed at waste sorting stations to identify and sort recyclable materials automatically. Sim et al. (2019) describe a machine learning algorithm that was developed to optimise waste collection routes in hotels, reducing the amount of fuel consumed by waste trucks and improving the efficiency of waste collection, which indicates that AI can be used to optimise waste collection routes, reducing the amount of fuel that is consumed by waste trucks. This not only saves money but also reduces greenhouse gas emissions.

Water conservation

Water is a precious resource, and hotels consume large amounts of it. Singhal et al. (2019) provide an overview of the current state of research on hotel water management, including using machine learning algorithms to detect leaks and optimise water treatment processes. AI can monitor and reduce water usage in several ways, such as by analysing water consumption patterns and identifying areas where water is being wasted. For example, AI algorithms can detect leaks in water systems and alert hotel staff to the problem to address it quickly. Majumdar et al. (2021) describe the potential of AI to help hotels conserve water, with a focus on machine learning algorithms, computer vision, and other AI tools; AI can be used to optimise water treatment processes, reducing the amount of water that is wasted during treatment.

Personalised guest experience

Sadhwani and S. P. Singh (2021) discuss the potential of AI to provide a more personalised guest experience in the hotel industry, with a focus on machine learning algorithms, chatbots, and other AI tools, indicates AI can also help hotels provide a more personalised guest experience while minimising waste. Herrero et al. (2020) review the current state of research on personalising hotel guest experience, including using machine learning algorithms to analyse guest feedback and preferences. For example, by analysing guest preferences and behaviour patterns, hotels can anticipate and provide the services and amenities that guests are most likely to use and appreciate. This can help reduce waste from amenities provided but not used by guests.

In summary, there is a growing body of literature on using AI in the hotel industry to promote sustainability and provide a more personalised guest experience. These studies demonstrate the potential of AI to help hotels reduce their environmental impact while improving the guest experience and operating costs. Overall, AI can be a powerful tool for promoting sustainability in the hotel industry. By optimising energy consumption, reducing waste, conserving water, and providing a personalised guest experience, hotels can reduce their environmental impact while still providing high-quality services. While there are some concerns about the use of AI in the hotel industry, there is not a significant amount of negative literature on the topic. However, some potential downsides have been identified by researchers, such as:

- **Privacy concerns**: the use of AI in the hotel industry may involve collecting and processing personal data, which can raise concerns about privacy and data protection. Some guests may feel uncomfortable having their data collected and analysed by AI algorithms (Abbasi & Alghamdi, 2019; Chen, W., & Li, X.,2021).
- **Job displacement**: AI in the hotel industry may lead to job displacement, as some tasks that human employees currently perform may be automated. This could have negative consequences for employees who are replaced by AI systems (Choi & Choi, 2019; Xie, Liang, Li, & Wang, 2020).
- **Dependence on technology**: AI in the hotel industry may make hotels more reliant on technology, which could be problematic if the technology fails or malfunctions. This could lead to disruptions in hotel operations and dissatisfied guests (Abbasi & Alghamdi, 2019; Xie, Liang, Li, & Wang, 2020).

- **Cost**: the implementation of AI systems in hotels can be expensive, which may make it difficult for smaller hotels to adopt these technologies (Choi & Choi, 2019; Chung & Koo, 2019).

Opportunities of using AI after Covid-19 Pandemic in the Hotel Industry

The COVID-19 pandemic has caused significant changes in the hotel industry, with guest behaviour and hotel operations being significantly affected. AI technologies can help the industry adapt to these changes, increasing efficiency and sustainability. AI can be used for contactless check-in and check-out, predictive analytics for demand forecasting, enhanced cleaning protocols, personalised guest experiences, and sustainability initiatives. AI-powered chatbots and voice assistants for contactless check-in and check-out can reduce contact between guests and staff, minimising the risk of transmission of COVID-19 and other infectious diseases. Predictive analytics can help hotels forecast demand and optimise their pricing and inventory decisions. AI-powered robots and drones can perform routine cleaning tasks and detect areas that require additional attention, ensuring a safe and hygienic environment for guests. AI-powered systems can also help hotels reduce environmental impact by optimising energy consumption, reduce waste, water conservation and provide a more personalised guest experience. In summary, AI can help hotels reduce their environmental impact while still providing high-quality services to their guests.

Challenges

While there are some potential downsides to using AI in the hotel industry, it is essential to note that careful planning and implementation can address many of these concerns. Researchers and industry experts also widely recognise the benefits of using AI for sustainability, efficiency, and guest experience. The topic of AI reducing human touch in the service industry has been the subject of much discussion in recent years, with some arguing that the growing reliance on AI could have negative implications for service quality and customer satisfaction. A critical literature review of this topic, citing relevant studies to support the analysis.

Several studies have highlighted the potential risks associated with relying too heavily on AI in the service industry. For example, Zhang et al. (2020) argue that using chatbots and other forms of AI-driven customer service can lead to a "dehumanisation" of the service experience, as customers may feel less connected to the brand and less satisfied with the level of service they receive. Similarly, Mora et al. (2020) note that AI may be less effective in

handling complex customer queries, leading to customer frustration and dissatisfaction. However, it is also worth noting that AI can bring significant benefits to the service industry, particularly in improving efficiency and reducing costs. For example, Luo et al. (2019) find that using chatbots in customer service can reduce the time and expense of handling customer queries while improving response times and customer satisfaction. Wirtz et al. (2018) also suggest that AI can lead to more accurate and personalised service. AI algorithms can analyse large volumes of customer behaviour and preferences data to make tailored recommendations.

In conclusion, the literature on this topic suggests that the impact of AI on human touch in the hotel industry is complex and multifaceted. While certain risks are associated with relying too heavily on AI, such as a potential reduction in service quality and customer satisfaction, there are also significant benefits, such as improved efficiency and more personalised service. Therefore, service providers need to balance using AI to augment and enhance the service experience while maintaining a strong focus on human interactions and customer relationships.

Cases studies

Examples of Existing AI in the Hotel Industry

Here are some specific examples of how AI can be applied to promote sustainability in the hotel industry:

- **Energy conservation**: The InterContinental Davos hotel in Switzerland installed occupancy sensors in their guest rooms that automatically adjust the lighting, heating, and cooling systems based on whether the room is occupied. This has helped the hotel reduce its energy consumption by up to 20% (Siemens, n.d.). The Yotel hotel chain uses machine learning algorithms to analyse data on energy usage patterns, identifying areas where energy is wasted and making improvement recommendations. For example, they discovered that certain appliances in their guest rooms used more energy than necessary and could optimise their usage to reduce energy consumption (Hotel Management, 2019).
- **Waste management**: The Marriott hotel in Orlando, Florida, uses computer vision technology to sort and recycle waste more efficiently. Cameras are installed at waste sorting stations to identify and sort recyclable materials automatically. This has helped the hotel divert over 50% of its waste from landfills (Waste360, 2019). The Citizen M

hotel chain uses AI to optimise waste collection routes, reducing the fuel waste trucks consume. By analysing data on waste production and collection routes, they can determine the most efficient collection routes and reduce the number of trucks needed for waste collection (Sustainability Times, 2019).

- **Water conservation:** The Hilton Hotel in New York City uses machine learning algorithms to detect leaks in their water systems, reducing the amount of water lost due to leaks. This has helped the hotel reduce its water consumption by up to 5% (GreenTech Media, 2018).

The Crowne Plaza Hotel in Copenhagen, Denmark, uses AI to optimise its water treatment processes, reducing the amount of water wasted during treatment. By analysing data on water quality and usage patterns, they can adjust their treatment processes to minimise water waste (Green Journal, 2019).

- **Personalised guest experience:** The Henn-na Hotel in Japan uses AI-powered robots to provide a more personalised guest experience. The robots can interact with guests and learn their preferences over time, tailoring their recommendations and services to meet better the needs and preferences of individual guests (The New Yorker, 2018). The Hilton hotel chain uses machine learning algorithms to analyse guest reviews and feedback, identifying which amenities and services guests are most likely to use and appreciate. This helps them tailor their offerings better to meet the needs and preferences of their guests, reducing waste by avoiding amenities that are not commonly used (Hilton, 2017).

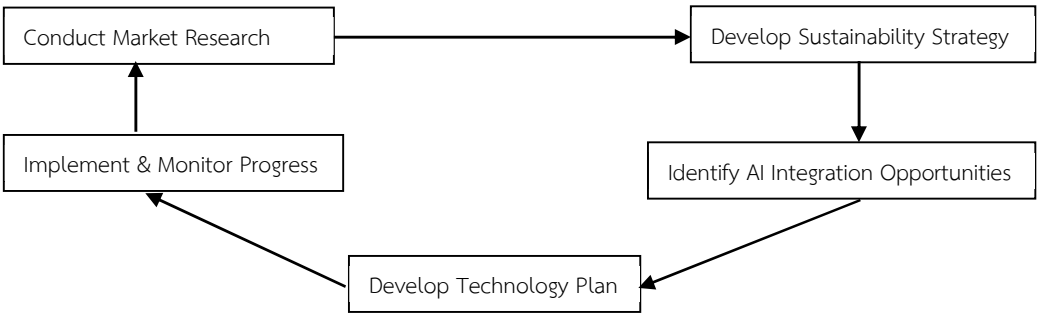
In summary, AI can be applied in various ways to promote sustainability in the hotel industry, from reducing energy consumption and waste to conserving water and providing a more personalised guest experience. These examples demonstrate the potential of AI to help hotels reduce their environmental impact while improving the guest experience and operating costs.

A Case Study of Sustainable Business Model in Hotel Industry in Chiang Mai, Thailand

Five Steps of Sustainable Business Model Development

This study focuses on transforming an approximately 140 rooms medium-scale local hotel into a sustainable business model and AI-powered hotel in Chiang Mai, Thailand, which includes five steps (Figure 1):

Figure 1: Five Steps of Sustainable Business Model Development in Chiang Mai Hotel



Source: Researcher's contributed

- **Step 1:** Conduct market research: To begin, it's essential to conduct thorough market research to understand the local demand for sustainable and tech-enabled hotel. According to a 2020 survey by Booking. com, 82% of Thai travellers prioritise sustainable travel, and 75% say they want to stay in eco-friendly accommodations. In addition, Chiang Mai has a growing tech industry, which could suggest a demand for AI-powered services.
- **Step 2:** Develop a sustainability strategy: Based on the market research, the hotel could develop a sustainability strategy that addresses areas like energy and water conservation, waste reduction, and responsible sourcing of food and materials. For example, the hotel could install solar panels, implement water-saving measures like low- flow showerheads and faucets, and implement recycling and composting programs. The hotel could also source local, organic produce from nearby farms and use environmentally friendly cleaning products. The Global Sustainable Tourism Council has developed criteria for sustainable hotel operations, which could serve as a helpful guideline for creating a sustainability strategy.
- **Step 3:** Identify opportunities for AI integration: Once the sustainability strategy is in place, the hotel could identify areas where AI technologies could be integrated to enhance sustainability and efficiency. For example, the hotel could install smart sensors to monitor energy usage and automatically adjust heating and cooling systems. AI-powered waste sorting robots, like those developed by Clean Robotics, could help to reduce waste by automatically separating recyclables from non-

recyclables. The hotel could also use machine learning algorithms to optimise inventory management and reduce food waste, as the Green Hotel in Amsterdam did. The hotel could also consider integrating AI-powered chatbots or other customer engagement tools to improve the guest experience.

- **Step 4:** Develop a technology plan: With the sustainability and AI integration plans in place, the hotel could develop a technology plan that outlines the specific systems and technologies to be used. This could involve selecting vendors for smart sensors and waste sorting robots, identifying software platforms for inventory management and food waste reduction, and developing an Application Programming Interface (API) for chatbot or other AI-powered services. The hotel could also invest in high-speed internet and other infrastructure to support tech-enabled services.
- **Step 5:** Implement and monitor progress: Once the hotel is up and running, it's essential to implement the sustainability and technology plans and continually monitor progress towards sustainability goals. This could include tracking energy and water usage, waste reduction efforts, and customer feedback on the hotel's AI-powered services. The hotel could also consider pursuing sustainability certifications, such as Leadership in Energy and Environmental Design (LEED) or Green Key, to demonstrate their commitment to sustainability.

In conclusion, setting up a sustainable and AI-powered hotel in Chiang Mai would require careful planning, investment, and ongoing monitoring to ensure that the hotel's sustainability and technology initiatives align with the local market and the property's unique needs.

Sustainable Business Model with AI Technology

Here is an example of a sustainable business model for a hotel that incorporates the use of AI technology to enhance sustainability and guest experience:

- **Revenue streams:** The hotel could generate revenue through room bookings, as well as additional services like dining, spa treatments, and tours of local sustainability initiatives.
- **Cost structure:** To minimise costs and enhance sustainability, the hotel could prioritise energy and water conservation, waste reduction, and responsible sourcing of materials and products. This could involve installing energy-efficient lighting, water-saving technologies like low-flow showerheads and faucets and using environmentally

friendly cleaning products. The hotel could also implement recycling and composting programs and source local, organic food and products to reduce transportation emissions. These sustainable practices could result in long-term cost savings and reduce the hotel's environmental footprint.

- **Key resources:** The hotel's key resources include staff, physical property, and technology infrastructure. To ensure the hotel's sustainability and AI initiatives are successful, the hotel would need to train staff on sustainable practices and develop and maintain a technology infrastructure that supports AI-powered services.
- **Key activities:** The hotel's key activities would include providing high-quality guest experiences, implementing sustainable practices, and integrating AI technologies to enhance sustainability and guest experience. This could involve developing personalised recommendations for guests based on their preferences using machine learning algorithms or smart sensors to optimise energy and water usage.
- **Value proposition:** The hotel would offer guests a unique, sustainable, and technology-enabled experience that aligns with their values. By implementing sustainable practices and integrating AI technologies, the hotel could differentiate itself from competitors and appeal to eco-conscious and tech-savvy travellers.
- **Customer relationships:** The hotel could foster customer relationships by providing high-quality, personalised experiences and engaging guests through AI-powered tools like chatbots or voice assistants. The hotel could also communicate its sustainability initiatives to guests and invite feedback to improve and refine its approach continually.
- **Channels:** The hotel could reach customers through online travel agencies, social media, and its website. The hotel could also partner with sustainability organisations or local businesses to promote its sustainability initiatives and engage with the community.

Overall, this business model would prioritise sustainability and AI integration to offer guests a unique and valuable experience while reducing the hotel's environmental footprint and long-term costs. This is just one example of a sustainable value business model, and many other approaches could be taken depending on a business's specific context and goals (Shukla et al., 2024; Talukder et al., 2024; Tan, 2021).

Five Sustainable Values Business Model

Elkington (1998) introduced the "triple bottom line" concept to measure sustainable business performance. The triple bottom line measures social, environmental, and economic performance. The business model aims to create value across all three dimensions in this study. The design strives to use sustainable practices that reduce the environmental footprint, such as implementing energy-efficient technology and minimising waste. This study also considers social impact by providing training and development opportunities for the local employees and engaging with local communities. Additionally, this business model aims to ensure the business is economically sustainable by pursuing revenue growth and profitability.

Lüdeke-Freund (2019) argues that sustainable entrepreneurship requires a co-evolutionary approach, which includes innovation and transformation. This business model will follow a co-evolutionary approach by continuously innovating and transforming our operations to improve sustainability. For example, the business model considers implementing sustainable practices in the supply chain and exploring new revenue streams that align with the sustainability goals. Schaltegger and Wagner (2011) propose that sustainable entrepreneurship and sustainability innovation are distinct but related categories. This business model will aim to create value in both categories by pursuing sustainable innovation and entrepreneurship. This study will explore new sustainable business opportunities and encourage innovation among local employees to achieve sustainability goals. By embracing sustainable entrepreneurship and innovation, the business model aims to create long-term value and positively impact the environment and society.

Regarding value captured and evaluated, performance is measured in terms of social, environmental, and economic impact. Using indicators such as carbon footprint, employee satisfaction, and profitability to assess the success of creating sustainable values. By tracking and analysing the performance, we can identify areas for improvement and continue to create value circularly and sustainably. Finally, the business model should be ensured to align with the United Nations' Sustainable Development Goals (SDGs). To focus on sustainable practices, social impact, and economic sustainability aligns with several SDGs, including goal 8 (decent work and economic growth), goal 12 (responsible consumption and production), and goal 13 (climate action), by aligning with the SDGs to create the sustainable values and contribute to global sustainability efforts. The innovative business model for the sustainable hotel in Chiang Mai could be extended to include value proposed, value created, value delivered, value

captured, and value evaluated, which this paper proposes (Figure 2): Five Values of Sustainable Business Model.

Value proposed: Offering sustainable and eco-friendly accommodations with a focus on reducing waste, conserving energy, and preserving the local environment; providing personalised and technologically-enhanced experiences to guests through the use of AI and automation technologies; supporting the local community by sourcing materials and products from nearby suppliers and promoting local culture and traditions; and encouraging sustainable tourism practices among guests and stakeholders, promoting responsible and ethical travel.

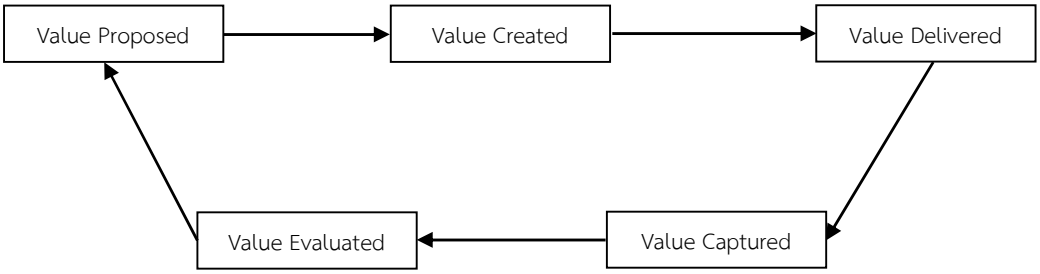
Value created: Creating a positive impact on the environment by reducing waste, conserving energy, and preserving natural resources; enhancing guest experiences by providing personalised and efficient services using AI and automation technologies; generating economic benefits for the local community by supporting local suppliers and promoting cultural tourism; fostering a culture of responsible and sustainable tourism, promoting ethical and environmentally friendly travel practices.

Value delivered: Providing sustainable and eco-friendly accommodations with state-of-the-art amenities and personalised services; supporting the local community by sourcing products and services from local suppliers and promoting cultural tourism; educating guests and stakeholders on sustainable tourism practices and promoting responsible travel; and fostering a culture of innovation and sustainability in the hotel industry.

Value captured: Generating revenue through hotel room sales, food and beverage services, and other complementary offerings; reducing operational costs by implementing sustainable practices and technologies; building brand reputation and loyalty among customers who value sustainable and eco-friendly accommodations; and attracting socially and environmentally responsible investors and partners.

Value evaluated: Measuring the impact of the circular business model on the environment, local community, and guest satisfaction; analysing the financial performance of the hotel in terms of revenue, costs, and profits; gathering feedback and insights from guests and stakeholders to improve the hotel's sustainability practices and services continuously; and tracking progress towards achieving SDGs and other sustainability targets.

Figure 2: *Five Values of Sustainable Business Model (PCDCE)*



Source: Researcher's contributed

Conclusion

The research explores the hotel industry development of a sustainable business model throughout Chiang Mai, Thailand, by incorporating artificial intelligence technology into sustainable practices. The study designed a complete change process that would transform a medium-scale hotel with 140 rooms into an AI-operated sustainable hospitality operation after the recovery of the pandemic. This research analyzed various content elements, starting with AI sustainability methods and moving through AI implementation barriers together with detailed applications of AI for energy efficiency, waste reduction, water resource protection and customer-specific personalized service delivery. These elements demonstrate how technology is vital for businesses to enhance environmental stewardship and operational performance.

The text evaluated the future possibilities and the multiple obstacles that AI systems have introduced to hotel companies since the start of COVID-19. It took note of personnel replacement challenges, security matters, monetary implications and technology reliability concerns. A five-step sustainable business model development framework with market research as its first step was introduced, with sustainability strategy formulation, AI integration, technology planning and implementation, and a continuous monitoring framework, offering practical guidance to hoteliers and policymakers.

Besides, the study advises improving the skillset of employees with specific courses in digital fields, program monitoring and data safety, to facilitate AI adoption in each department. Because of these strategies, employees will adjust well to AI-driven changes and use AI in different areas. Research findings also point to customized strategies that fit the size of each

hotel. It is possible for large hotels to automate their systems and invest in smart infrastructure. Medium-scale hotels ought to use smart energy management systems and guest service chatbots that are easy to adjust as needs change. On the other hand, small hotels might use cloud-based reservation software and property management software which saves on costs. Because education is delivered in stages, both inclusivity and sustainability can be guaranteed even if resources are limited.

Researchers created a sustainable business model canvas that includes vital components comprising revenue streams, cost structure, key activities, value propositions, and customer relationships. The model incorporates Elkington's Triple Bottom Line framework and extends to the Five Sustainable Values Framework for comprehensively understanding sustainable business development.

Applying sustainability strategies integrated with AI creates successful operational improvements together with satisfied guests and allows hotels to directly help achieve multiple United Nations Sustainable Development Goals (SDGs) 8, 9, 11, 12, 13 and 17. The hotel industry of Chiang Mai presents a game-changing opportunity to implement sustainability practices together with innovative technologies for achieving economic as well as environmental and social value. As a result, if AI strategies are tailored to different hotel sizes, focus on strengthening people and make sustainability central, the service-oriented model in Chiang Mai could be greatly improved. The case shows that other regional hotels can adapt to develop responsible innovation methods for long-lasting sustainability achievements.

Reference

Abbasi, A., & Alghamdi, A. (2019). Impact of Artificial Intelligence on the Hotel Industry. International **Journal of Engineering and Advanced Technology, 9**(2), 482-487.

Booking.com. (2020). **Sustainability: 82% of Thai travellers consider it to be a high priority when traveling.** https://globalnews.booking.com/sustainability-82-of-thai-travelers-consider-it-to-be-a-high-priority-when-traveling/

Chen, W., & Li, X. (2021). The Role of Artificial Intelligence in Smart Tourism Cities: Opportunities, Challenges and Implications. **Tourism Management, 82**, 104173.

Chiang Mai Citylife. (2020). **The future of Chiang Mai's tourism industry.** https://www.chiangmaicitylife.com/citynews/local/the-future-of-chiang-mais-tourism-industry/

Choi, J. H., & Choi, J. (2019). Artificial Intelligence in Hotel and Tourism: A Review of the Literature. **Journal of Hotel and Tourism Technology, 10**(1), 68-81.

Chuan, Z. L., Tan, L. K., Wee, A., Tham, Y. H., Ong, S. J., Low, J. Y., & Sai, C. Y. (2024). Sustainable Energy Management: Artificial Intelligence-Based Electricity Consumption Prediction in Limited Dataset Environment for Industry Applications. **MATEMATIKA**, 143–167. https://doi.org/10.11113/matematika.v40.n3.1594

Chung, N., & Koo, C. (2019). AI in the Hotel Industry: Is it a Boon or a Bane. **Journal of Hotel and Tourism Technology, 10**(3), 436-451.

Debnath, J., Kumar, K., Roy, K., Choudhury, R. D., & Krishna. (2024). Precision Agriculture: A Review of AI Vision and Machine Learning in Soil, Water, and Conservation Practice. **International Journal for Research in Applied Science and Engineering Technology, 12**(12), 2130–2141. https://doi.org/10.22214/ijraset.2024.66166

Elkington, J. (1998). **Cannibals with forks: The triple bottom line of 21st century business.** Capstone.

Green Journal. (2019). **Crowne Plaza Copenhagen Towers – Putting sustainability at the heart of business.** https://www.greenjournal.co.uk/crowne-plaza-copenhagen-towers-putting-sustainability-at-the-heart-of-business/

GreenTech Media. (2018). **Hilton's NYC hotels cut water use by 23% with AI.** https://www.greentechmedia.com/articles/read/hiltons-nyc-hotels-cut-water-use-by-23-with-ai

Herrero, Á., Sanz, A., & Ruiz, M. (2020). The impact of artificial intelligence on the tourism industry. **Journal of Hotel and Tourism Technology, 11**(3), 343-359. https://doi.org/10.1108/JHTT-05-2019-0065

Hilton. (2017). **Hilton Hotels & Resorts pilots artificial intelligence technology to transform guest experiences.** https://newsroom.hilton.com/corporate/news/hilton-hotels-resorts-pilots-artificial-intelligence-technology-to-transform-guest-experiences

Hotel Management. (2019). **AI, machine learning help Yotel optimise energy usage, improve guest experience.** https://www.hotelmanagement.net/tech/ai-machine-learning-help-yotel-optimize-energy-usage-improve-guest-experience

Kim, H. W., & Lee, G. (2018). The impact of smart hotel technology on hotel guest satisfaction: A pilot study. **International Journal of Contemporary Hotel Management, 30**(1), 158-180.

Kim, J. H., & Lee, C. K. (2018). The impact of artificial intelligence on tourism: Opportunities and challenges. **Journal of Travel Research**, 0047287518812050.

Lüdeke-Freund, F. (2019). Business models for sustainability: A co-evolutionary analysis of sustainable entrepreneurship, innovation, and transformation. **Journal of Cleaner Production, 208,** 883-896.

Luo, X., Huang, L., & Liu, Z. (2019). Chatbots and customer service: A systematic review and future research directions. **International Journal of Information Management, 49**, 161-174.

Majumdar, A., Das, A., & Dutta, S. (2021). Application of Artificial Intelligence in Water Management of Hotels. **Journal of Hotel and Tourism Technology, 12**(1), 146-161.

Mora, M., Neaga, E., & Ricci, F. (2020). Artificial intelligence in customer service: An exploratory study. **Journal of Business Research, 112**, 513-522.

Nguyen, T. V., Roshandel, R., Wong, K. W., & Lo, K. W. (2020). **Occupancy-based Energy**

Payne, P. M., & Rawlins, K. (2019). Using Artificial Intelligence to Reduce Energy Consumption in Hotels. **Journal of Hotel and Tourism Technology, 10**(1), 101-116.

Rhallab, O. (2024). Water and electricity consumption management architectures using IoT and AI: A review study. **Materials Research Proceedings.** https://doi.org/10.21741/9781644903216-20

Sadhwani, S. P., & Singh, S. P. (2021). Artificial Intelligence and Personalised Guest Experience in Hotel Industry. In D. Tomar, A. Kumar, A. Tiwari, & J. L. Rueda-Medina (Eds.), Digital Marketing Strategies for Tourism, Hotel, and Airline Industries (pp. 147-157). IGI Global. https://doi.org/10.4018/978-1-7998-4255-5.ch009

Schaltegger, S., & Wagner, M. (2011). Sustainable entrepreneurship and sustainability innovation: Categories and interactions. **Business Strategy and the Environment, 20**(4), 222-237.

Shukla, A., Yadav, N., Khunasathitchai, K., & Tiwari, A. (2024). Best Practices for the Hotel and Tourism Industry Applying AI. **Advances in Hospitality, Tourism and the Services Industry (AHTSI) Book Series,** 123–148. https://doi.org/10.4018/979-8-3693-7898-4.ch007

Siemens. (n.d.). **InterContinental Davos (Switzerland) – Sensor-based room automation.** https://new.siemens.com/global/en/markets/hotels/intercontinental-davos.html

Sigala, M. (2020). Tourism and COVID-19: Impacts and implications for advancing and resetting industry and research. **Journal of Business Research, 117,** 312-321.

Sim, R. L., Goh, M., & Khoo, H. L. (2019). Optimising Waste Collection Routes in Hotels Using Machine Learning. **Journal of Environmental Management, 232,** 445-454.

Singhal, S. S., Sharma, N., & Sharma, R. (2019). Water Management in Hotels: A Review. **Journal of Hotel and Tourism Technology, 10(**2), 285-305.

Singhal, S. S., Sharma, N., & Sharma, R. (2020). Smart and Sustainable Waste Management in Hotels: A Review. **Journal of Hotel and Tourism Technology, 11(**1), 61-81.

Sustainability Times. (2019). **citizenM: Using AI to reduce carbon footprint.** https://sustainabilitytimes.com/citizenm-using-ai-to-reduce-carbon-footprint/

Szczepaniuk, H., & Szczepaniuk, E. K. (2023). Applications of Artificial Intelligence Algorithms in the Energy Sector. **Energies, 16**(1), 347. https://doi.org/10.3390/en16010347

Talukder, M. B., Kabir, F., & Jibon, F. A. (2024). AI-Driven Personalized Room Management in the Modern Hotel Industry. **Advances in Hospitality, Tourism and the Services Industry (AHTSI) Book Series,** 59–82. https://doi.org/10.4018/979-8-3693-5678-4.ch003

Tan, Y. S. (2021). **Harvesting a New Synergy: Exploring "Smart and Green" Hotels within the Context of the Irish Hospitality Industry.** SWORD - South West Open Research Deposit. https://doi.org/10.34719/2T82-N935

The New Yorker. (2018, April 23). **The robot-run hotel.** https://www.newyorker.com/magazine/2018/04/23/the-robot-run-hotel

Tourism Authority of Thailand. (2020). **Northern Thailand tourism promotion plan.** https://www.tatnews.org/2020/06/tat-outlines-tourism-promotion-plan-for-northern-thailand/

Tussyadiah, I. P., & Park, S. (2018). Consumer evaluation of hotel service robots. **International Journal of Contemporary Hotel Management, 30**(2), 1143-1161.

Waste360. (2019). **Marriott uses AI to combat food waste.** https://www.waste360.com/recycling/marriott-uses-ai-combat-food-waste

Wirtz, J., Grewal, D., Neal, D., Baker, T., Parasuraman, A., & Motyka, S. (2018). Technology as a service delivery innovation: The role of customer support services. **Journal of the Academy of Marketing Science, 46**(4), 643-657.

Xie, K. L., Liang, X., Li, X., & Wang, D. (2020). How can artificial intelligence transform the hotel industry? A review of the literature. **Journal of Hotel and Tourism Technology, 11**(4), 656-669.

Zhang, H., Lu, Y., Gupta, S., & Wang, B. (2020). The impact of artificial intelligence on customer experience: Contingent role of service type. **Journal of Business Research, 117,** 364-373.