

Design Thinking Approach for Sustainable Hospitality: A Smart Mobile Management System for Indonesia

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Abstract

Background The hospitality industry in Indonesia is facing increasing pressure to become sustainable as the government has implemented regulations and initiatives aimed at promoting sustainable tourism. This research uses a design thinking approach to address the challenge of creating sustainable solutions for the hospitality industry in Indonesia. Specifically, this study aims to develop a smart mobile management system, NEXA, to help hotels reduce plastic waste from physical cards and to improve overall sustainability practices.

Methods This research applied a design thinking approach, encompassing empathy, definition, ideation, prototyping, and testing stages, involving diverse Indonesian stakeholders through qualitative interviews and surveys. Data analysis employed thematic analysis and the Leximancer tool to uncover customer needs and pain points, informing the development of NEXA. Rooted in addressing low sustainability awareness in the Indonesian hospitality sector, the study synthesized inputs from customers, hotel staff, managers, and IT professionals. The ideation process included mind mapping, benchmarking, DALL-E visualization, and storyboarding, resulting in a user-friendly mobile app prototype.

Results This research applied a design thinking approach, encompassing empathy, definition, ideation, prototyping, and testing stages, involving diverse Indonesian stakeholders through qualitative interviews and surveys. Data analysis employed thematic analysis and the Leximancer tool to uncover customer needs and pain points, informing the development of NEXA. Rooted in addressing low sustainability awareness in the Indonesian hospitality sector, the study synthesized inputs from customers, hotel staff, managers, and IT professionals. The ideation process included mind mapping, benchmarking, DALL-E visualization, and storyboarding, resulting in a user-friendly mobile app prototype.

Conclusions The design thinking approach is successfully proposed by the study to develop NEXA based on the triple diamond framework. By integrating the double diamond philosophy into the triple diamond, the authors could explore the problem and find the best solution for sustainable hospitality in Indonesia. As a result, the concept of Smart Mobile Key with Green Ride generates positive feedback regarding stakeholder interest in sustainable stays.

Keywords Design Thinking, Sustainability, Hospitality, Technology, Innovation

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1. Introduction

The hospitality industry in Indonesia faces pressing sustainability challenges as the government emphasizes sustainable initiatives through regulatory measures (Maspul, 2021). Given the substantial growth of tourism in the region, the imperative to reduce waste and protect the environment becomes even more critical (Sunlu, 2003). Research has indicated that the hotel industry in Central Kalimantan lacks adequate sustainability initiatives, primarily due to its excessive energy consumption (Rhama & Setiawan, 2022). Consequently, the hotel industry must proactively enhance its competitiveness and raise awareness through innovative and sustainable approaches (Floričić, 2020).

Design thinking has proven to be a valuable tool in resolving complex problems within the hospitality industry, placing a strong emphasis on addressing human needs throughout the design process (Brown, 2009; Chung & Chung, 2018). Holistic approaches have also been extensively utilized within the hospitality industry to comprehend the impact of various challenges on customers (Jones & Dent, 1994).

This research paper presents a significant contribution to the field of design thinking and sustainable hospitality by introducing NEXA, a smart mobile management system, developed through an integrated approach combining design thinking and design management principles. By integrating these two disciplines, the study demonstrates how a holistic approach can foster innovative and sustainable solutions for the Indonesian hospitality industry.

Furthermore, NEXA's features and functionalities have been purposefully designed to address specific sustainability challenges faced by hotels, ensuring enhanced strategic alignment (Lamelas, Lamelas, & Filipe, 2015). Additionally, design thinking brings user-centricity to the forefront of NEXA's development, fostering user acceptance and engagement, thereby increasing the potential for successful implementation (Camillo & Camillo, 2019).

The integration of design thinking and design management also enables cross-disciplinary insights, leading to a more comprehensive and effective solution. This integrated approach enables NEXA to address sustainability practices while respecting cultural norms within the Indonesian hospitality industry (Ahmed et al., 2021). By reducing plastic waste and introducing sustainable features without disrupting existing cultural practices, NEXA presents a unique and culturally sensitive solution, facilitating the adoption of sustainable practices and promoting positive stakeholder engagement (Pham et al., 2019).

Through its various contributions, this research advances our understanding of the effective combination of design thinking and design management to develop innovative and sustainable solutions for the hospitality industry. The integrated approach demonstrated in this study offers valuable insights for design practitioners and researchers seeking to apply these principles in other real-world contexts (Hsieh, 2012).

2. Literature Review

2. 1. Significance of Sustainability in Hospitality Industry

The hospitality industry in Indonesia faces sustainability challenges as the government encourages sustainability initiatives through regulations (Maspul, 2021). Given the growth of tourism, it is crucial to reduce waste and protect the environment (Sunlu, 2003). Research has highlighted the lack of sustainability initiatives in the hotel industry of Central Kalimantan, attributed to excessive energy consumption (Rhama & Setiawan, 2022). Consequently, there is a need for an innovative and sustainable approach to maintain competitiveness and increase awareness in the hospitality industry (Floričić, 2020). Design thinking has proved valuable in solving complex problems in the hospitality industry (Chung & Chung, 2018). By focusing on human needs in the design process, designers can create solutions that align with user needs, motivations, and constraints to address challenges effectively (Brown, 2009).

The integration of design management and design thinking principles in this study presents a significant contribution to the field of sustainable hospitality, as evidenced by its focus on NEXA, a smart mobile management system. This integration fosters strategic vision, enhances alignment with sustainability objectives, and promotes user-centric innovation, enabling a robust and culturally sensitive solution (Brown, 2009; Liedtka, 2014). The comparative analysis approach offers insights into the environmental and economic benefits of NEXA, positioning it as an environmentally friendly and economically viable solution for the hospitality industry (Khan & M, 2021; Chen & Chen, 2021; Jones & Dent, 1994). By embracing a cross-disciplinary perspective, the study combines the strengths of design thinking and design management, leading to a comprehensive and effective solution for sustainable hospitality (Busulwa et al., 2022; Mousavian et al., 2023; Assen et al., 2023; Kurek et al., 2023).

Moreover, NEXA's integrated approach addresses sustainability practices while respecting cultural norms, encouraging the adoption of sustainable practices and promoting positive stakeholder engagement (Ahmed et al., 2021; Pham et al., 2019; Hsieh, 2012). By advancing the understanding of the combined potential of design thinking and design management, this research offers valuable insights for design practitioners and researchers in various real-world contexts.

2. 2. Sustainable Practice in Design

Human-centred design principles, grounded in empathy and understanding of users' needs, have gained prominence in driving sustainable design solutions, with HCI practices like ethnographic research, user interviews, and testing enabling deeper insights into user behaviours, preferences, and sustainability-related pain points (Phetteplace & Etches, 2013). Past research highlights the increasing concern for environmental sustainability in HCI since 2007 and proposes a practice-oriented perspective to redefine sustainability problems and foster sustainable change (Pierce et al., 2013). Social innovation is explored for enhancing community resilience and addressing environmental changes, emphasizing local culture,

network connectivity, and empowerment (Wang et al., 2023). Traditional HCI approaches are critiqued for environmental sustainability, suggesting a focus on scale and political, cultural, and spatial aspects in design (Dourish, 2010).

By adopting a practice-oriented approach inspired by Brenda Laurel's "Design Research: Methods and Perspectives," this research explores sustainability complexities in the hospitality industry, redefining problems through an alternative analytic frame and developing innovative solutions that consider broader aspects (Laurel, 2003). Integrating usability and environmental concerns is essential in sustainable design practices for the hospitality industry (Issa & Isaias, 2015). A cross-disciplinary initiative aims to integrate sustainability concerns into software engineering practice (Becker et al., 2015). A new model for interaction design research within HCI advocates research through design, fostering collaboration with engineering and behavioural science researchers to tackle wicked problems (Zimmerman et al., 2007). Integrating human-centred design methodologies empowers users to adopt eco-friendly practices and fosters responsibility toward sustainability.

HCI plays a pivotal role in sustainable design by leveraging technology for positive environmental and social impact, integrating smart technologies, IoT devices, and data analytics to create resource-efficient solutions (Pappas et al., 2023). Eco-feedback technology is explored for reducing environmental impact and promoting sustainable behaviours, and intelligent energy management systems offer promising solutions for optimizing energy consumption (Froehlich et al., 2010; Mohammadi et al., 2018). Smart energy systems are studied for achieving synergies and sustainability (Xu et al., 2020). Mobile applications promoting sustainable behaviours empower users to actively participate in sustainability (e.g., eco-friendly transportation) while enhancing user experiences for long-term engagement with sustainable design solutions.

Achieving sustainable outcomes requires collaboration among diverse stakeholders, including designers, users, businesses, policymakers, and local communities (Chairs et al., 2019). The importance of cultural competence in interdisciplinary collaborations is emphasized, advocating for understanding and valuing diverse perspectives to achieve effective solutions (Reich & Reich, 2006). A multifaceted framework of transformative sustainable business models is proposed, considering external dynamics, digital technologies, and shared-value logic to generate novel value propositions (Brenner, 2018). Collaborative human-computer systems, sustainable HCI, and participatory design are highlighted to promote sustainable practices (Lindblom et al., 2016).

However, integrating HCI and collaborative stakeholder engagement in sustainable design practice faces challenges, including data protection and ethical considerations (Gutwirth, 2009). Inter-organizational big data collaborations and the concept of Corporate Digital Responsibility (CDR) are proposed to address ethical concerns (van den Broek & van Veenstra, 2018; Lobschat et al., 2021). Effective collaboration may encounter barriers related to differing agendas, power dynamics, and resource constraints (Jiang & Ritchie, 2017). Nevertheless, the successful implementation of sustainable design initiatives holds promise for transformative positive impacts on the environment and society.

Numerous successful case examples demonstrate the integration of HCI and collaborative stakeholder engagement in sustainable design projects. For instance, a sustainable urban mobility app was developed through collaboration with city authorities, transportation companies, and citizens, resulting in an eco-friendly solution. Participatory approaches in stakeholder analysis were emphasized in environmental decision-making processes to better represent stakeholders (Reed et al., 2009). Smart cities, IoT, and smart tourism in Greece were comprehensively reviewed, highlighting the significance of mobile technologies and smart solutions in hospitality (Kapiki, 2021). Participatory design in sustainable community spaces involved residents, reflecting local values and encouraging sustainability. Citizens' active participation and design cooperation were proposed as key to large-scale, sustainable changes, with designers adopting different roles and using diverse design devices to promote social conversations (Manzini & Rizzo, 2011). These examples illustrate the efficacy of human-centred and collaborative approaches in driving impactful and socially responsible sustainable solutions.

In the context of the hospitality industry in Indonesia, this research adopts a sustainable design approach that integrates human-centered principles and stakeholder engagement, aided by HCI tools, to create impactful and socially responsible solutions. Through collaborative partnerships, the study aims to co-create context-specific and inclusive sustainable solutions, addressing the challenge of reducing plastic waste from physical cards and improving overall sustainability practices in hotels. Despite challenges, this integrated approach shows promise in building a more sustainable and equitable future for the hospitality industry in Indonesia.

2. 3. Frameworks for Sustainable Design in Hospitality

Design thinking, renowned for its problem-solving capabilities, has emerged as a potent framework for fostering sustainability in the hospitality industry (Brown, 2009). Its human-centred approach enables a deeper understanding of stakeholder needs, paving the way for tailored solutions. In Indonesia, where the digital age has revolutionized everyday objects through smart mobile apps (Moggridge, 2007), integrating design thinking with the triple diamond framework holds immense promise in addressing sustainability challenges within the hospitality sector.

Design thinking effectively tackles abstract problems (Kelley et al., 2016), enabling the hospitality industry to gain profound insights into customer preferences and needs, crucial for sustainable practices. In Indonesia, where sustainability awareness is low, design thinking is vital for identifying root causes and developing targeted smart mobile application solutions that cater to local users. Integrating the triple diamond framework, inspired by Suoheimo et al. (2022), fosters cross-disciplinary collaboration, leading to context-specific and inclusive sustainable solutions.

Considering design thinking as a cognitive style and resource (Kimbell, 2011) and emphasizing human values and creativity in design-driven innovation (Auernhammer & Roth, 2021) ensures that smart mobile applications align with diverse user needs, enhancing overall experiences. Fu et al. (2023) highlighted various perspectives on design thinking,

guiding the development of innovative and creative solutions for Indonesian stakeholders. Implementing design thinking in transdisciplinary industry-academia research (Gonera & Pabst, 2019) fosters collaboration and practical outcomes for sustainable hospitality and smart mobile applications. The integration of design thinking with the triple diamond framework in Indonesian hospitality, particularly through user-centric smart mobile applications like NEXA, facilitates the creation of innovative and inclusive solutions that address the specific needs of Indonesian users, thereby promoting a more sustainable and user-centric future.

3. Methodology

This research uses a design thinking approach called triple diamonds (Figure 1). This approach is based on the double-diamond framework developed by the British Design Council (Design Council, 2019). In this process, divergent and convergent thinking are combined. Traditionally, double diamonds emphasize the problem definition at the start and its solution at the end; that is, a design problem has already been determined (Design Council, 2019). However, a key objective of this study is to discover the root cause of the lack of sustainability in Indonesian hospitality and suggest possible solutions. Thus, the problem is undefined. The third diamond was added to explore a more innovative and creative means of resolving the ambiguous problem.

As presented in Figure 1, the second diamond convergent step was “envision,” which combined ideas from the first diamond to create a proof of concept. The third diamond focused on proving the concept outlined in the second diamond by building and testing it. Furthermore, the third diamond produced a prototype and solution based on the second diamond to create wireframes for a working model based on the proof of concept through design development and delivery.

The triple diamond design process (Figure 1) began with discovery, which, in this case, involved a literature review, stakeholder mapping, and a qualitative data gathering (Table 1) to acquire the information needed for innovation (Martin, 2009). The second step was to define the problem using Leximancer’s analysis tool and thematic analysis method to capture key patterns and insights from the data to identify innovation opportunities based on the information gained from the “discover” stage. As part of the “define” phase, there was a “develop” phase in which the survey analysis outcome resulted in possible solutions for the stakeholders (Figure 4).

Next, in the “ideate” stage, the potential solutions from the “define” and “develop” phases are explored. It involves developing concepts and generating ideas using a mind map (Table 1). In addition, to the mind map, a customer journey map (Table 1) was created to visualize the customer’s journey from being aware of the smart mobile management system to receiving hotel services. Considering what customers see, say, hear, think, and feel, an empathy map a customer journey map (Table 1) was used in conjunction with the customer journey for

a better understanding of their experience. The idea was visualized with DALL-E (an AI program that develops images based on textual descriptions) to give potential solutions. Furthermore, it visualized the customer journey for the smart mobile management system through a storyboard to explore potential solution scenarios. As the “ideate” stage comes to an end, the third diamond begins, which is regarding developing the prototype.

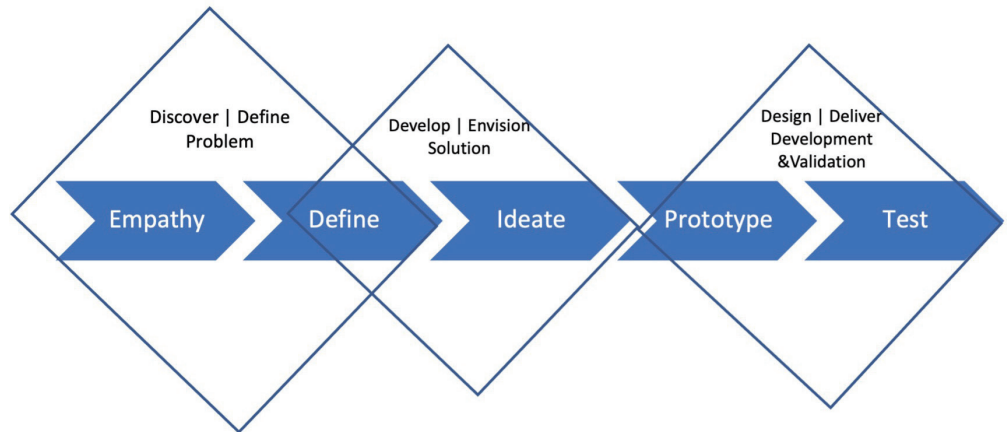


Figure 1 Triple Diamond Design Process expansion based on Double Diamond (Design Council, 2017)

Table 1 Design Flow

Steps	Design Flow
1	Literature Review
2	Stakeholder Map
3	Qualitative Data Gathering
4	Analyze the Data Using Thematic Analysis and Leximancer
5	Mind Map
6	Customer Journey with Empathy Map
7	Visualize Ideas with DALL-E, Storyboard
8	Sketching and Developing Prototype
9	Test Prototype
10	Review Feedback

The ideas delivered at the “ideate” stage are explored, and solutions are narrowed through convergence. Therefore, this research developed prototype sketches and designed a smart mobile management system, which could be tested with the stakeholders based on the “empathize” phase. The final part of the diamond was to deliver the prototype, which was tested by the stakeholders, including the customer, hotel manager, hotel staff, and the IT department. Finally, based on review and feedback, the solution was refined for future research.

4. Result

4. 1. Empathize

This research employed a design thinking approach to address sustainability issues in the Indonesian hospitality industry. The stakeholder map categorized key players into four groups: Customers, Hotel Staff, IT Department, and Hotel Managers. This approach aligns with prior research on stakeholder engagement (Busulwa et al., 2022).

To ensure ethical research, this research obtained consent from all participants. The qualitative interview with a design thinking expert and hotel customers, followed by a survey with stakeholders, provided valuable insights. These methods draw from previous studies on design thinking (Chung & Chung, 2018) and ethical research (Gutwirth, 2009).

Customers are essential stakeholders as end-users of sustainable initiatives. Their feedback and preferences are crucial in shaping sustainable offerings and experiences to meet their needs. Hotel Staff play a vital role in executing sustainability strategies and can provide valuable insights on the practicality and effectiveness of such measures. The IT Department's technical expertise is pivotal in implementing technological solutions for sustainability, ensuring feasibility and smooth functioning. Hotel Managers, as decision-makers, hold the authority to approve and implement sustainability initiatives.

Furthermore, this research was meticulously designed to encompass qualitative data gathering through interviews and surveys, ensuring adherence to ethical principles and data confidentiality. Prior to conducting any data collection, explicit and informed consent was obtained from all participants, both for the qualitative interviews and the subsequent survey. The consent forms outlined the purpose of the research, the types of data to be collected, the voluntary nature of participation, and the measures taken to protect participant identities and responses.

In the initial stage of the research, a qualitative interview was conducted with an expert in design thinking, who also possessed the unique perspective of being a hotel customer and two customers in the hospitality sector. The interview was conducted online, and took place between provided valuable insights into the core problem of sustainable hospitality in Indonesia. One of the key questions asked was, "In your opinion, what are the main barriers to implementing sustainable practices in the hotel?"

Subsequently, the research proceeded with the qualitative survey, aimed at gaining diverse perspectives from four stakeholders identified in the stakeholder map (Figure 2) to find the main barriers to implementing sustainable practices in the hotel. This insight was acquired from February to March 2023. Another question asked after the formulation problem from both interview and survey was, "Which sustainable hotel technology do you consider important in a hotel?" This gave them options, based on the literature review, such as renewable energy sources (e.g., solar, wind) and smart guest engagement systems (e.g., a mobile app for check-in and check-out, personalized lighting, temperature settings,

and digital concierge services). The open-ended response section allowed stakeholders to elaborate on their choices, facilitating a comprehensive understanding of their perspectives.

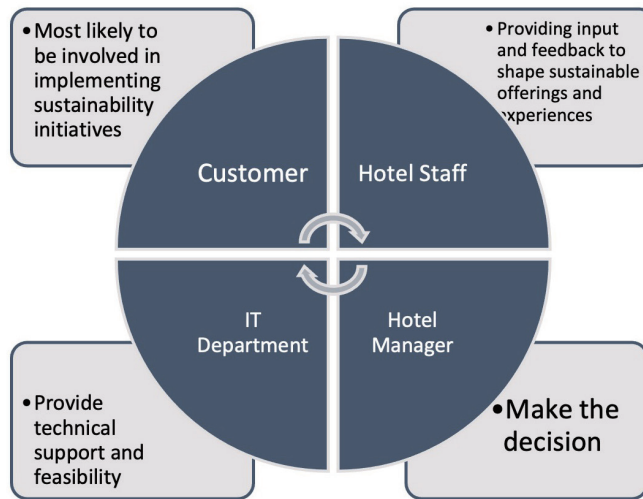


Figure 2 Stakeholder map

The research approach respects cultural norms while promoting sustainability, echoing previous studies (Ahmed et al., 2021; Reich & Reich, 2006). This research has relevance across various contexts, emphasizing human-centered approaches in sustainable design practices.

Therefore, by adopting a comprehensive design thinking approach, encompassing stakeholder engagement and ethical data collection, to develop sustainable solutions for Indonesia’s hospitality industry. This approach holds promise in building a more sustainable and equitable future for the sector, aligning with previous research on sustainability in design and stakeholder involvement (Chen & Chen, 2021; Lindblom et al., 2016).

4. 2. Define

In the define stage, a qualitative analysis was employed to examine both interview and survey data. The qualitative analysis of both the interview and survey data was instrumental in shaping the research direction, providing a comprehensive understanding of stakeholder perspectives and informing the exploration of sustainable solution, while thematic analysis identified key sustainable practice themes.

4. 2. 1. Qualitative analysis Interview

This section elaborates a qualitative analysis of interviews conducted with an expert in design mentor and two customers in the Indonesian hospitality sector. These interviews offer invaluable insights that significantly shape the exploration of sustainable hospitality in Indonesia in this research.

Participant 1 Perspective:

Participant 1 emphasise the importance of customer awareness and concern regarding sustainability issues within hotels, stating, “Not all customers in Indonesia are environmentally conscious,” and “Some prioritize convenience over eco-friendly practices.” His insight aligns with existing literature, which highlights the significance of sustainability initiatives encouraged by the Indonesian government (Maspul, 2021), and resonates with the need to reduce waste and protect the environment, especially in a growing tourism industry (Sunlu, 2003).

He further mentioned that financial constraints within hotel management can hinder sustainability efforts, in agreement with research highlighting excessive energy consumption as a hindrance to sustainability initiatives (Rhama & Setiawan, 2022). Additionally, the idea that “Eco-friendly hotels tend to be more expensive” and that “The cost of sustainability initiatives may contribute to higher prices” aligns with the concept of limited financial resources acting as a barrier to sustainability in the hotel industry. This underscores the need for inventive and sustainable strategies to ensure competitiveness and ecological responsibility (Floričić, 2020).

Regarding technological innovation and adoption, Participant 1 mentioned that “An app-based check-in system reduces the need for plastic keycards,” but also expresses doubts about the “widespread adoption of such innovations due to complexity.”

Participant 2 Perspective:

Participant 2’s insights align with existing literature on sustainability in the hospitality sector (Krippendorff, 2019). He highlights the significance of technology and regulations in driving sustainability in hotels.

Participant 2 shows a strong awareness of sustainability, especially in reducing plastic waste, stating, “I view sustainability practices positively, especially in reducing plastic waste. Hotels are major contributors to plastic pollution.” This underscores his understanding of the environmental challenges faced by the hospitality industry due to plastic pollution.

He also points out the challenges hotels face in implementing sustainability, particularly in waste management, saying, “Waste management is a significant challenge. It requires commitment from hotels and awareness among guests.” This emphasizes the need for collaboration between hotels and guests in waste management, consistent with previous research (Chairs et al., 2019; Reich & Reich, 2006; Brenner, 2018).

Regarding the awareness of sustainability practices among hotel stakeholders, Participant 2 notes, “Hotels are becoming aware of plastic waste, but guests sometimes bring plastic items from outside.” This suggests that while hotels are making efforts to raise awareness, there is still a need for educating guests, in line with existing research on human-centered and collaborative approaches (Reed et al., 2009; Kapiki, 2021; Manzini & Rizzo, 2011).

Participant 3 Perspective:

Participant 3 as a design expert, emphasizes hotels taking the primary responsibility for sustainability practices, “Responsibility for sustainability in hotels should fall on the hotel itself, not just the customer,” aligning with various sustainable design frameworks (Brown, 2009; Suoheimo et al., 2022; Kelley et al., 2016; Gonera & Pabst, 2019) and This viewpoint aligns with the concept of corporate responsibility in sustainability (Gutwirth, 2009).

Participant 3 emphasise the need for transparency in sustainability efforts, as shown by the quote: “As a customer, I support hotels that are transparent about their sustainability efforts,” which can attract eco-conscious guests. Furthermore, Participant 3 suggest adopting innovative technologies, like Apple’s app clips, in line with tech’s role in advancing sustainability (Pappas et al., 2023), drawing inspiration from practical solutions (Reed et al., 2009; Kapiki, 2021; Manzini & Rizzo, 2011).

4. 2. 2. Qualitative analysis survey

The qualitative analysis of survey data builds upon the insights from the interviews and offers a comprehensive view of stakeholders’ perspectives within the Indonesian hospitality industry. The analysis of the qualitative survey was carried out using Leximancer (Goh & Wilk, 2022), which helped identify the frequency of words and how they appeared together in the survey. A total of 100 participants took part in the survey, including 74 customers, 6 hotel managers, 2 hotel staff, and 18 IT Department members (Appendix 1).

In this research, qualitative methods play a central role, echoing Lenberg et al.’s (2023) emphasis on their significance in understanding human behavior. The selection of Leximancer aligns with Braun et al.’s (2020) support of its adaptability. Jansen’s (2010) insights into qualitative surveys have informed the methodology, addressing sample size concerns raised by Belanovskiy (2023). Thematic Analysis (TA), a widely-used qualitative methodology (Braun & Clarke, 2022), forms the backbone of the approach. Insights from Krippendorff’s work on content analysis (2019) are also integrated.

The research leverages Leximancer as the chosen tool, not just for theme identification but also for enhancing credibility and validating consistent themes, consistent with Harwood et al.’s observations (2015). This choice resonates with Lemon and Hayes’ findings regarding Leximancer’s ability to unveil subtle themes and bolster research outcomes (2020). The investigation, influenced by Tseng et al. (2015) and Goh & Wilk (2022), seeks to uncover barriers within Indonesia’s hospitality industry regarding sustainable practices (Figure 3). Leximancer, a well-established qualitative data analysis tool (Kivunja, 2013), fortifies the research by efficiently mining and visualizing data using Concept Maps, thereby reducing researcher subjectivity. Its rigor is further strengthened through validation against manual content analysis (Engstrom et al., 2022). However, it’s important to acknowledge that for smaller datasets, more immersive approaches like manual thematic analysis may be preferable, despite their time-intensive nature.

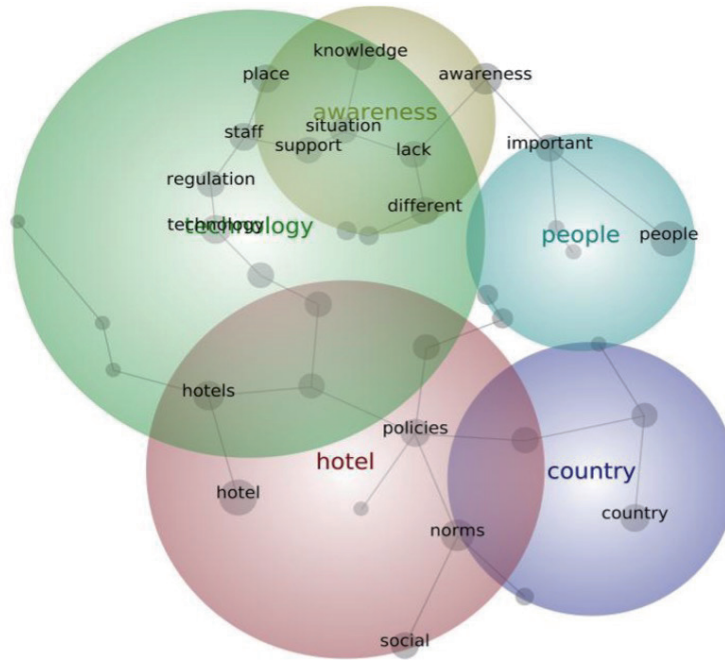


Figure 3 Concept map for theme using Leximancer (Goh & Wilk, 2022)

Table 2 Stakeholder's Input

Stakeholder	Theme	Comment
Customers	Knowledge + Awareness + Norms + Finance	"Some hotels cannot perform their idea about sustainability because of financial problems in their management. Lack of awareness and knowledge is also an obstacle; it is difficult to explain to people who have no clue about sustainability. The hardest ones to break are the cultural and social norms, especially when your idea exists against the norms. No argument can break the norms, which have existed for long."
Customers	Finance + Technology + Regulation	"If the money is limited, the hotel doesn't afford sustainability. Thus, to achieve sustainability, access to technology and regulations is a must."
Hotel Manager	Knowledge + Awareness	"Awareness and knowledge are very important for the implementation of sustainability in a hotel."
Hotel Employees	Knowledge + Awareness	"Some people in the community and the customers may not know about sustenance-friendly things that are not present in the hotel. Therefore, the hotel services should at least inform them through a bulletin board or a hotel flyer. Some norms that are implied in the community might also have an impact on the implementation of sustainability in the hotel."
IT Department	Finance + Technology + Culture	"Yes, managing hotel property is high risk. It's about financial management and technological impact. The regulations are confusing. It is also about the culture that runs near the property."

Drawing from the feedback collected through the survey, a network of interconnected concepts emerged, revealing key themes (Table 2). Through this analysis, several challenges within Indonesia's hospitality sector were unveiled, creating barriers to the seamless incorporation of sustainable practices.

Survey Findings:

The survey gathered responses from diverse stakeholders, revealing critical themes.

Common Themes from Survey Responses:

1. **Financial Constraints:** Both customers and the IT department emphasized financial limitations as significant obstacles to sustainability, corroborating the existing literature (Groves, 2009). Hotels' financial struggles (Floričić, 2020) and the link between sustainability and financial management are evident (Lenberg et al., 2023).
2. **Importance of Awareness and Knowledge:** Hotel managers and employees stressed the significance of awareness and knowledge in sustainability implementation, in line with Gimbel & Newsome's (2018) emphasis on understanding stakeholders' perspectives.
3. **Cultural and Social Norms:** Customers and hotel employees pointed out cultural and social norms as potential barriers to sustainability. This mirrors existing research (Floričić, 2020) that underscores the need to navigate cultural norms in sustainability initiatives.

Differences in Stakeholder Perspectives:

Technology and Regulations: Customers emphasized the importance of access to technology and regulations for achieving sustainability, echoing the role of technology and regulations in sustainability initiatives (Pappas et al., 2023). On the other hand, the IT department discussed the complexities of managing technological impacts and navigating confusing sustainability regulations (Gutwirth, 2009).

By gaining insights from interviews and surveys, this research aim to provide a holistic solution for reducing plastic waste in Indonesian hotels. This approach ensures that the proposed solution aligns with the multifaceted perspectives and challenges identified by key stakeholders, underscoring the relevance and responsiveness of this research to the Indonesian hospitality sector's needs.

The research problem statement identified the need to develop a tool that facilitates sustainable practices in the hospitality industry while preserving Indonesian culture. The proposed solution must be cost-effective, easily understandable, and meet the preferences of all stakeholders.

4. 2. 3. Stakeholder Perspectives on Sustainable Solutions

Upon recognizing the sustainability challenges within Indonesia's hospitality sector, stakeholders collaboratively pursued viable solutions. This research identified the need for a cost-effective tool that promotes sustainability while preserving Indonesian culture in the hospitality sector. Stakeholders, including customers, IT members, managers, and staff, explored eco-friendly options such as energy-efficient lighting, renewable energy, smart management, guest engagement systems, water conservation, waste management, green transportation, health and wellness enhancements, and improved accessibility.

The data showed a strong preference for "Smart Guest Engagement Systems" among customers (73%) and hotel managers (86%), emphasizing the appeal of personalized digital services. Hotel staff (86%) leaned towards "Renewable Energy Sources," emphasizing energy

efficiency, while the IT department (93%) favored “Smart Guest Engagement Systems,” highlighting the importance of technology in guest interactions. This data reveals a consensus for the “Smart Guest Engagement Systems” while showcasing distinct stakeholder preferences.

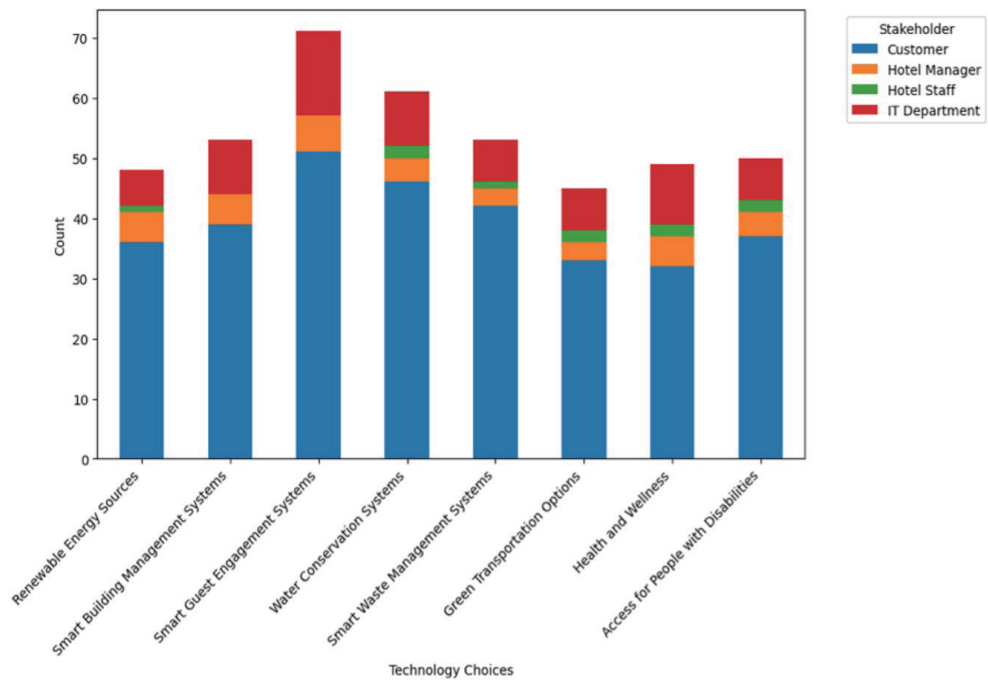


Figure 4 Stakeholder Preferences for Sustainable Hotel Technologies

4. 3. Ideate

To address the problem statement identified in the “define” stage, the ideate stage involved developing creative ideas and potential solutions. As a first step, a mind map was created to generate ideas, engage the stakeholders, structure concepts, expand perspectives, and identify relationships (Figure 5).

This mind map was used to identify six potential features for the smart mobile management system, named NEXA – smart key, wellness and health, smart energy management, sustainable transport, sustainable dining, and ecotourism (Figure 5). Taking into account the practicality and feasibility of the stakeholders, the smart key was deemed to be the most important and useful feature. The smart key feature included check-in, check-out, mobile key, bill payment, and energy management. Smart keys would be integrated with sustainable transport options and wellness and health options to provide a comprehensive solution for sustainable hospitality in Indonesia.

However, NEXA must explore potential challenges and limitations arising from its implementation. The technology may not be understood by the stakeholders, and they may be concerned about privacy and security. As a result, it would be important to ensure the system is easy-to-use, reliable, and secure.

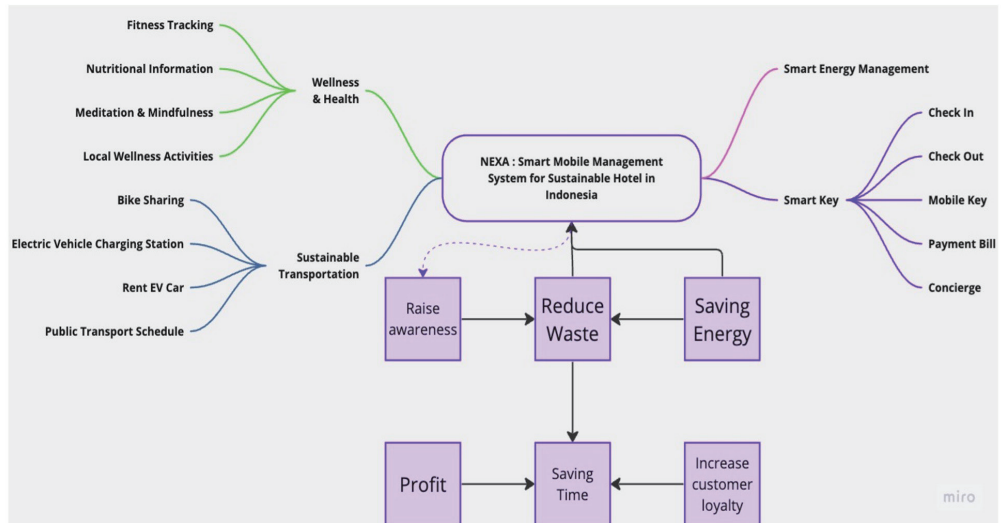


Figure 5 Visual ideation using mind map

A benchmarking process was conducted to research currently available solutions. It involved discovering the hospitality industry’s achievements. As shown in Figure 6, Hilton, Marriot, and Hyatt currently have mobile applications that allow users to open room doors using mobile keys and have received positive feedback for the same. In addition, their mobile application offers loyalty points and a convenient and sustainable method of room booking to the members.

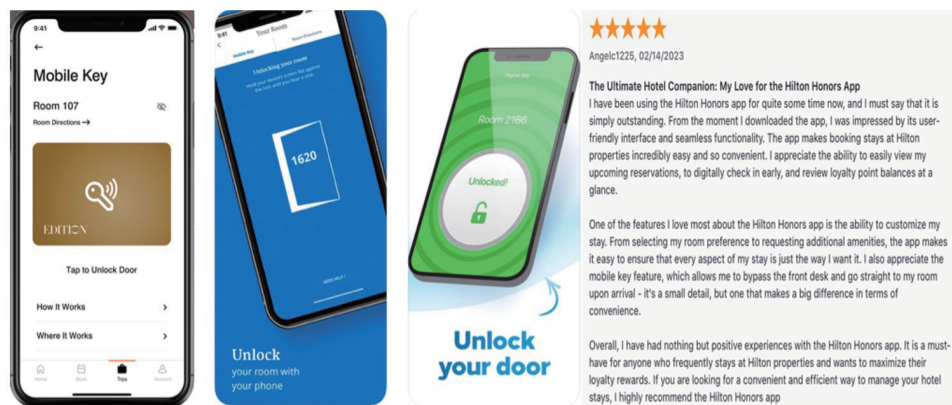


Figure 6 Benchmark with Marriott (Marriott, n.d.), Hyatt (Hyatt, n.d.), Hilton (Hilton, n.d.), and Hilton Reviews (Hilton Worldwide, 2013)

However, it is inconvenient to download a different app for every hotel. In this research, the “ideation” stage aimed at designing a mobile application that could be used by all hotel members, regardless of the hotel. The app would allow Indonesian stakeholders to access their bookings and mobile key, along with other sustainable features, in one place. A customer journey map was created based on the empathy map to understand the relationship between the customer and NEXA over time and across channels (Figure 7). Through this approach, this research sought to understand how customers’ expectations are met and identify areas for improvement, including exploring their emotions and feelings as they go through the process.

The customer journey map breaks down the interaction with a sustainability-focused hotel app into three main phases: pre-service, service, and post-service. It closely examines customer actions, touch-points, emotions, pain points, and potential solutions.

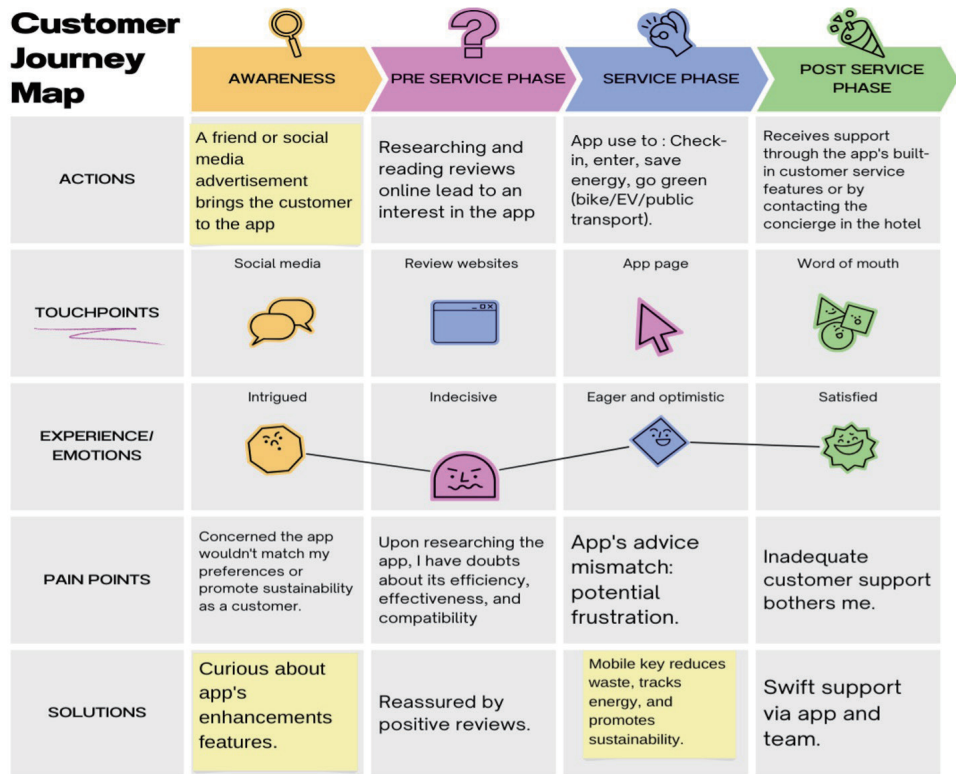


Figure 7 Customer Journey

Pre-Service Phase: Customers begin their journey by discovering the app through friends or social media, driven by the promise of a sustainable hotel experience. They conduct thorough research and carefully scrutinize reviews, mirroring findings from prior research highlighting the importance of effective customer journey design (Kuehnl et al., 2019). This phase serves as the starting point, shaping their initial expectations and impressions.

Service Stage: Once customers download the app, it seamlessly integrates into their hotel experience. It equips them with various features, including convenient check-in, room access, energy monitoring, and eco-friendly transportation options. This aligns with earlier research emphasizing the holistic and satisfying nature of the user experience (Bradley et al., 2021). The app also acts as an important channel for immediate customer support and interaction with the hotel concierge, ensuring a smooth stay.

Post-Stay: Following their stay, customers provide feedback through the app, a process similar to the enriched Customer Journey Maps (CJMs) discussed in previous research. These CJMs aim to comprehensively capture user experiences, helping organizations identify pain points, improve their offerings, and gain deeper insights into user personas (Alvarez et al., 2020). Additionally, this post-stay interaction becomes a touch-point for customers to consider future bookings through the app.

Throughout this journey, the map shows customer concerns regarding the app's efficiency and its impact on sustainability. Furthermore, it captures the customer's eager anticipation of a convenient and sustainable hotel experience, in line with the consequentialist approach that prioritizes overall satisfaction and pleasure among users.

Furthermore, the research utilized text-to-image generators, like DALL-E (Paananen, Oppenlaander, & Visuri, 2023), to transform text descriptions such as "futuristic hospitality open door with smart mobile," "sustainable hospitality in Indonesia in the future," and "holistic sustainable transportation in hotels" into images (Figure 8) (Ramesh et al., 2022).



Figure 8 Visual ideation using DALL-E 2 (Ramesh et al, 2022)

From stakeholder input, industry benchmarks, and customer journey insights, we distilled NEXA's core concepts. This includes a multifaceted mobile management system with smart key functionality, covering check-in, check-out, door access, energy control, integration with sustainable transportation, and wellness amenities. NEXA aims to redefine sustainable hospitality, prioritizing user-friendliness and security.

This innovation aligns with enhancing guest experiences and sustainability, in line with AI Ideation design principles (Tholander & Jonsson, 2023). These principles emphasize the synergy between machine learning models like DALL-E and human interpretation, facilitating innovative visual outcomes guided by semantic prompts (Vermisso, 2022).

In the last part of the ideation stage, a storyboard was created to illustrate how the proposed features of NEXA may interact with potential users, a technique found in past research exploring creative, visual, and multimodal methods in sociology (Ayrton, 2020). This approach helps in understanding complex social phenomena, such as trust, by providing a visual representation of the user experience.

The storyboard depicted a person sitting in a car, reviewing a smart mobile management system on their phone, illustrating the user experience. When the user arrives at a hotel, they can access all aspects of their stay using their phones, including check-in and a smart mobile key to open the room door. Through this storyboard, the motivation and rationale behind the solution were clarified, aligning with the use of storyboarding in research design (Ayrton, 2020).



Figure 9 Storyboard

Storyboarding enhances research by fostering reflexivity, revealing new dimensions, and promoting holistic understanding, challenging traditional practices (Ayrton, 2020). Therefore, the motivation and rationale behind the solution were clarified, and a better understanding of the situation was achieved for this research.

4. 4. Prototype

The prototype stage of this research involved the development of the third diamond of design thinking, which allowed proper development of the prototype wireframes, exploring design concepts from the ideation stage for NEXA. The low-fidelity prototype development, inspired by Bill Buxton's 'Sketching User Experiences' (2007) and guided by Figure 5, as shown in Figure 10, played a pivotal role in this research. These sketches visually conveyed design concepts and essential functionalities for our sustainable hospitality app. They outlined the mobile app's preliminary design, featuring a slide key for door access and room energy control, including lighting and temperature management.

Our adoption of sketching techniques echoes Marquardt and Greenberg's emphasis (2015) on paper-pencil sketches in HCI research and design projects. These quick methods proved effective in generating and refining design ideas for user experiences. This approach also aligns with Lotz and Sharp's findings (2017) in their studies of novice interaction designers, emphasizing the use of sketch-based methods.

The next step involved the development of high-fidelity wireframes, which connected the information in NEXA with its visual design, demonstrating ways to display specific types of information on the user interface and demonstrating the paths between pages. By ensuring that the prototype closely represented the intended functionality of the user interface, the research collected respondents' actual experiences and opinions about sustainability. In addition, it collected respondents' interest in using NEXA in Indonesia to promote sustainable practices.

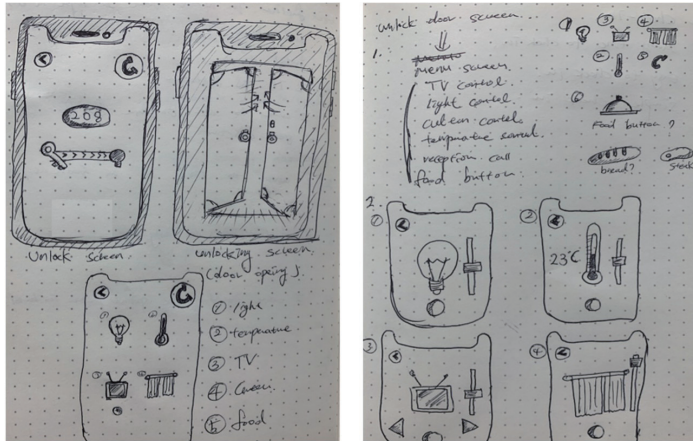


Figure 10 Sketches

The development of high-fidelity wireframes, illustrated in Figure 10, involved connecting NEXA’s information with its visual design. This process demonstrated how specific information would be displayed on the user interface and how users would navigate between pages. This step aimed to ensure that the prototype accurately represented the intended user interface functionality. Through this, the research collected respondents’ real experiences and opinions regarding sustainability and their interest in using NEXA in Indonesia (Maspul, 2021; Sunlu, 2003; Rhama & Setiawan, 2022).

One wireframe prototype showed the login and booking page for check-in (Figure 11). This feature enabled users to access all their reservations through NEXA, streamlining the check-in process and reducing paper waste, aligning with cultural norms and sustainability objectives (Floricić, 2020; Chung & Chung, 2018). Mobile check-in not only eliminates the need for paper-based procedures but also reduces energy consumption by eliminating physical key cards (Brown, 2009).

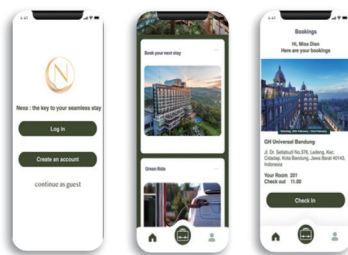


Figure 11 Prototype – Login, Main page, booking page to Check In

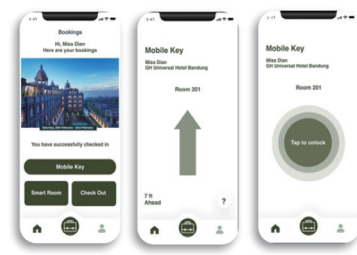


Figure 12 Prototype – Mobile key

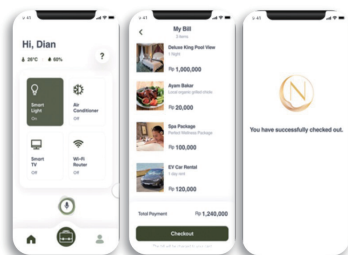


Figure 13 Prototype – Smart Room, Check Out & Bill

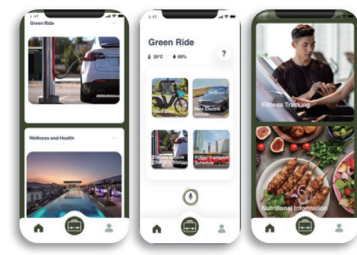


Figure 14 Prototype – Green Ride, Wellness & Health

Figure 12 showcases the booking page after check-in, featuring a mobile key for room access. This mobile key eliminates the need for plastic key cards, contributes to reducing environmental impact, and provides additional functionalities like room directions, enhancing user-friendliness (Norman, 2016). Figure 13 empowers guests to manage their room's energy consumption, further promoting sustainability (Khan & M, 2021; Chen & Chen, 2021; Jones & Dent, 1994).

Figure 14 also provides fitness tracking and nutrition information on the app's health and wellness page. According to research, hotels and resorts could benefit from offering sustainable transportation options. According to Genikomsakis et al., hotels that offer bike rentals attract environmentally-conscious guests, increasing both returns on investment and internal rate of return (Genikomsakis et al., 2021). This feature reduces food waste and encourages sustainable consumption by providing nutritional information to guide guests' choices. Fitness trackers promote eco-friendly transportation options like walking or biking, contributing to a reduction in their carbon footprint (Pierce et al., 2013; Froehlich et al., 2010; Mohammadi et al., 2018).

4. 5. Test

There were 100 respondents in the test, including 77 hotel customers, 4 hotel managers, 6 hotel staff, and 13 IT department members (Appendix 2). To raise interest in hotel sustainability, respondents were given either the mobile key concept or the green ride and wellness concept. Each concept was tested to a 50/50 ratio on each question. They were provided with other concepts in other questions to understand their genuine reaction and perception toward smart mobile management solutions.

4. 5. 1. A/B Testing

An A/B test was conducted to understand which concept raised stakeholder interest in sustainability. Two concepts were involved in this research – Smart Key and Green Ride & Wellness. The “smart mobile key” respondents were randomly given a different concept and asked whether or not the concept was relevant to them in terms of sustainability. A total of 42% found the concept extremely relevant and 44% found it moderately relevant, suggesting that smart mobile key received positive feedback regarding sustainability (Table 3). One respondent mentioned, “This technology will help reduce plastic or metal lock waste and make hotel room entry and organization more efficient.” (Appendix 2)

Table 3 A/B Testing Result

	Smart Mobile Key		Green Ride and Wellness	
	Answers	Count	Answers	Count
Extremely relevant	42.00%	21	36.00	18
Moderately relevant	44.00	22	56.00	28
Slightly relevant	10.00	5	6.00	3
Neither relevant nor irrelevant	4.00	2	2.00	1
Moderately irrelevant	0.00	0	0.00	0
Extremely irrelevant	0.00	0	0.00	0

Thus, while smart keys would introduce digitalization into hotel keys to increase sustainability, it would make hospitality more efficient. 36% of the “green ride” respondents felt that the concept was extremely relevant, and 56% felt that it was moderately relevant to them (Table 3), which means that the concept received positive feedback. As one respondent pointed out, “It’s important to recognize the importance of living an environmentally friendly lifestyle and its impact on the planet; by making small changes in our daily life, we can contribute to a more sustainable future,” which means that green rides could change the culture of a society and make it more caring toward the environment and promote a healthy lifestyle; thus, initiating sustainability activities without pressurizing the society to change.

4. 5. 2. Smart mobile key concept and green ride increase respondent’s interest in sustainability

This research found the smart key and green ride prototypes increased the interest of most respondents (99%) in sustainability (Appendix 2). There is a lack of knowledge and awareness regarding sustainability in Indonesian hospitality, as mentioned in the “define” stage of this research. While the Indonesian culture does not embrace sustainability, mobile technology concepts could encourage individuals to take action and care for the environment. Smart keys were found to increase interest in sustainability due to their efficiency. As one representative of the IT department stated, “Yes, this makes me interested in the development of this technology in the hospitality field.” (Appendix 2).

For the green ride, users agreed that it increased their interest in sustainability. One respondent mentioned, “Yes, this prototype makes me interested in sustainability in the hotel industry. Also, I am looking forward to its contribution.” (Appendix 2). This shows that the lack of awareness in hospitality could be solved through design thinking. Certain respondents mentioned, “People nowadays love to follow the trends. EV is a new trend. I think it is good for the hotel if it can always catch up with the latest trends.” (Appendix 2). Providing existing trends in green rides could increase stakeholders’ use of green vehicles. Smart keys and the green ride would contribute to increasing sustainability awareness in Indonesia and slowly changing the culture and norms. Simple steps, such as not using physical card keys, could reduce plastic waste and other related waste. In addition, the green ride would provide alternatives to fossil fuel cars, making a difference in Indonesian hospitality.

4. 5. 3. Motivating users to use the smart mobile system with green rewards

Respondents suggested that rewarding those who save energy would motivate guests to use the green option in NEXA, “and for less energy use, maybe a small gift as a token of sustainability.” (Appendix 2). This would encourage hotel users to do good, increase customer loyalty, and establish the hotel as an industry leader, thereby boosting profits. In addition, NEXA could be a long-term investment for reducing overall costs.

4. 5. 4. Technical problems and adaptability

Respondents were concerned about NEXA’s technical problems and data security, “the access to the system has to be so secure. I don’t want anyone to be able to access everything as I do (unless it’s an emergency).” (Appendix 2). Hence, future developers must consider technicalities and data security. Therefore, further research is required to make users

feel safe while using a smart key and green ride management system. Moreover, clear instructions must be provided since habits take time to change. As one respondent pointed out, “Some customers or guests may find it difficult or be reluctant to download an app to access hotel rooms. It also takes time for guests to adjust to this technology.” (Appendix 2). In this case, adaptability would be a challenge. However, as Indonesia follows trends, gradually implementing sustainable actions would change the habits of Indonesia’s hospitality industry, leading to greater sustainability.

5. Conclusion

A design thinking approach was successfully proposed by the study to develop smart mobile management systems based on the triple diamond framework. By integrating the double-diamond philosophy into a triple-diamond framework, the hospitality industry could explore the problem and find the best solution for sustainable hospitality. Thus, the concept of a smart mobile key with a green ride generated positive feedback regarding stakeholder interest in sustainable stays.

6. Implication

This research offers a practical solution which has the potential to significantly reduce plastic waste and enhance overall sustainability practices in the Indonesian hospitality industry. By leveraging smart mobile technology to introduce sustainable concepts, this research presents a promising avenue for raising awareness and fostering environmentally responsible behaviors among both hotel staff and guests.

Furthermore, the integration of design thinking and sustainability principles in the development of NEXA provides a valuable model for future sustainable design initiatives in the hospitality sector, not only in Indonesia but also in similar global contexts. This study highlights the importance of a user-centric approach and cross-disciplinary collaboration, emphasizing the need for designers, researchers, and industry professionals to work collectively in addressing complex sustainability challenges.

Finally, the findings highlight the potential of smart technology in encouraging sustainable habits and demonstrate that environmentally friendly solutions could be both user-friendly and cost-effective. However, because the research recognizes some technological difficulties and adaption challenges, it opens the door to future research in order to ensure the seamless application of sustainable technology. Overall, this design research adds to the growing discussion on sustainable design practices by emphasizing the positive impact of human-centered methods to achieve environmental and social goals

7. Limitation

The research's design methods rely on a small sample size of stakeholders, which might not sufficiently reflect the range of potential user experiences and opinions in Indonesia. To gain deeper insights from a more diverse group of stakeholders, future researchers could consider conducting a more expanded number of interviews and observations.

Additionally, as design research often involves iterative processes, the final prototype presented here represents a snapshot in time and may require further refinements and adaptations based on real-world implementation and user feedback. Furthermore, the study emphasizes the conceptualization and early-stage development of the NEXA system, with potential technical challenges and user acceptance issues not fully explored at this stage. These limitations underline the need for future research to expand upon the groundwork laid here and ensure the practicality and efficacy of sustainable design solutions in diverse hospitality contexts.

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