การพัฒนาแผนยุทธศาสตร์สำหรับเทศบาลนครเชียงใหม่เมืองอัจฉริยะเพื่อส่งเสริมการดำเนินโครงการริเริ่มด้านพลังงานอัจฉริยะและสิ่งแวดล้อมฉลาด

Development of a strategic plan for the Smart City of Chiang Mai Municipality to enhance smart energy and environmental initiatives

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Abstract

The smart city development by Chiang Mai Municipality focuses on promoting inclusivity, accessibility, and standardized technologies to improve the residents' quality of life by raising environmental awareness and adopting low-carbon practices. Within the Energy and Environment Sector, there are four distinct scenarios that prioritize sustainability and innovation. This study evaluates the appropriateness of initiatives that employ a social engagement approach in order to improve smart energy and environmental endeavors. The methodology comprises the preparation of the Strategic and Initiatives of Chiang Mai Universal Smart City, the implementation of the Social Engagement Process or Public Hearing Responsibilities Data, and the analysis of appropriate initiatives through triangulation. The strategic plan emphasizes the initiatives aimed at achieving both environmental sustainability and technological advancement. By collecting questionnaires, we can ensure inclusivity and expand public awareness. The notable initiatives are green spaces to improve ecological diversity and air quality. Primary endeavors encompass the establishment of air monitoring stations and the advocacy for sustainable energy sources such as LED lighting and electric vehicle charging infrastructure. Expert assessments are in line with the objectives set by the government, with a strong focus on environmental progress and subsequent improvements in the energy sector. The progressive approach encompasses both short-term and medium-term stages, systematically tackling environmental and energy challenges. The primary focus is on improving the Smart Environment, followed by advancements in both areas, with the goal of promoting sustainable urban development and improving the overall quality of life in Chiang Mai.

Keywords: Smart City, Strategic plan, Chiang Mai Municipality, Energy, Environment

บทคัดย่อ

การพัฒนาเทศบาลนครเชียงใหม่เมืองอัจฉริยะมุ่งเน้นไปที่การส่งเสริมความเท่าเทียม การเข้าถึง และเทคโนโลยีที่ได้เหมาะสมเพื่อปรับปรุงคุณภาพชีวิตของผู้อยู่อาศัยด้วยการสร้างความตระหนักรู้ด้านสิ่งแวดล้อมและการมุ่งสู่การลดการปลดปล่อยคาร์บอนในภาคพลังงานและสิ่งแวดล้อม โดยแบบจำลองสถานการณ์ของเชียงใหม่มืองอัจฉริยะสามารถแบ่งออกได้สี่สถานการณ์ที่ให้ความสำคัญกับความยั่งยืนและนวัตกรรม งานวิจัยนี้เป็นการประเมินความเหมาะสมของโครงการริเริ่มโดยการใช้แนวทางการมีส่วนร่วมทางสังคม เพื่อพัฒนาแผนยุทธศาสตร์การพัฒนาเทศบาลนครเชียงใหม่เมืองอัจฉริยะด้านพลังงานและสิ่งแวดล้อม โดยเริ่มจากการเตรียมยุทธศาสตร์และโครงการริเริ่มของเมืองอัจฉริยะสากลเชียงใหม่ จากนั้นดำเนินการตามกระบวนการมีส่วนร่วมทางสังคม และทำการวิเคราะห์โครงการริเริ่มที่เหมาะสมผ่านกระบวนการสามเส้า ทั้งนี้พบว่าแผนยุทธศาสตร์จากภาคประชาชนเน้นย้ำโครงการริเริ่มที่มุ่งบรรลุทั้งความยั่งยืนด้านสิ่งแวดล้อมและความก้าวหน้าทางเทคโนโลยี แต่ยังไม่ละทิ้งและให้ความสำคัญกับการเพิ่มพื้นที่สาธารณะและพื้นที่สีเขียว ซึ่งจะช่วยปรับปรุงความหลากหลายทางนิเวศวิทยาและคุณภาพอากาศ ความพยายามเบื้องต้นครอบคลุมถึงการจัดตั้งสถานีตรวจสอบอากาศและการสนับสนุนแหล่งพลังงานที่ยั่งยืน รวมถึงโครงสร้างพื้นฐานสำหรับรถไฟฟ้า ทั้งนี้สอดคล้องกับการประเมินโดยผู้เชี่ยวชาญและงานวิจัยที่เกี่ยวข้องโดยมุ่งเน้นที่ความก้าวหน้าด้านสิ่งแวดล้อมและการปรับปรุงในภาคพลังงาน แนวทางก้าวดำเนินโครงการครอบคลุมทั้งระยะระยะสั้นและระยะกลาง โดยจัดการกับความท้าทายด้านสิ่งแวดล้อมและพลังงานอย่างเป็นระบบ เป้าหมายหลักคือการปรับปรุงสภาพแวดล้อมอัจฉริยะ ตามด้วยความก้าวหน้าในทั้งสองด้าน โดยมีเป้าหมายเพื่อส่งเสริมการพัฒนาเมืองที่ยั่งยืนและปรับปรุงคุณภาพชีวิตโดยรวมในเชียงใหม่

คำสำคัญ: เมืองอัจฉริยะ แผนยุทธศาสตร์ เทศบาลนครเชียงใหม่ พลังงาน สิ่งแวดล้อม

Introduction

The scenario for the development of Chiang Mai Municipality towards a smart city prioritizes inclusivity, accessibility, and standardized technologies to facilitate environments and services benefiting all residents. Emphasizing fair and equal access to digital services, promotion of environmentally friendly practices, and encouragement of innovation, this scenario aims to foster a comprehensive and inclusive approach to urban development globally. Aligned with the city's dedication to sustainability, innovation, and public involvement, its objective is to enhance the quality of life for all residents by promoting environmental awareness and integrating low-carbon practices into growth and resilience strategies. Regarding the scenario in the Energy and Environment Sector, emphasis is placed on sustainability, innovation, and technological advancement. Four distinct scenarios outline Chiang Mai's multifaceted approach to smart city development: "Smart City Plus," prioritizing low-carbon practices and resilience against climate change; "Smart City Prestige," focusing on technology leadership through investment in smart transportation, energy solutions, and waste management; "Smart City Innovation," highlighting engagement in innovation initiatives to drive economic growth and technological advancement; and "Universal Smart City," emphasizing inclusivity, accessibility, and standardized technologies, prioritizing equitable access to digital services and sustainability.

The public hearing process constitutes a methodology of social engagement, providing a formal procedure for individuals from the general public to express their perspectives, concerns, and viewpoints on specific issues, proposals, or undertakings potentially affecting them or the community. Integral to the democratic process, public hearings ensure openness and inclusiveness in decision-making, particularly concerning policies, regulations, or projects with significant public consequences. Such hearings offer a platform for individuals or group representatives to voice their opinions, provide input, and express approval or disapproval regarding a particular matter or proposal. Conducted by governmental entities, regulatory authorities, or organizations responsible for decisions affecting the public, public hearings aim to facilitate transparent communication, gather diverse perspectives, and consider community interests before making

consequential decisions. The data collected during these hearings informs and shapes final determinations or regulations established by the governing entity or overseeing organization [1-3].

This research focuses on employing social processes to evaluate and provide opinions on issues and initiatives in the development of Chiang Mai Municipality as a smart city. The research objective is to assess the suitability of initiatives for the development of Chiang Mai Municipality's Smart City and devise a strategic plan with a social engagement approach to enhance smart energy and environmental initiatives.

Research Methodology

Researchers use various methods to test theories and analyse data, utilizing both quantitative and qualitative approaches, such as focus groups, interviews, and surveys. Mixed methods combine different research techniques, like pairing observations with interviews or focus groups, depending on the study's goals and the most suitable methods.

The Chiang Mai Municipality has developed strategic initiatives for the Smart City. These initiatives include a preliminary strategy plan that was derived from the Scenario for Chiang Mai Universal Smart City. The plan was introduced to stakeholders through an open dialogue. The goal was to actively involve the community in the decision-making process. This open dialogue provided a chance for the public to participate, allowing for community consultation to gather recommendations and suggestions for the review and completion of the plan [4-5]. In order to obtain thorough feedback, a virtual public hearing was organized, allowing a minimum of 400 participants to participate and complete questionnaires. The research methodology will be segmented into three distinct components, encompassing the procedures for preparing and consolidating the Strategic and Initiatives of Chiang Mai Universal Smart City, with a primary emphasis on energy and the environment. The second part involves conducting the Social Engagement Process or Public Hearing Responsibilities Data, while the third step entails analyzing suitable initiatives through triangulation

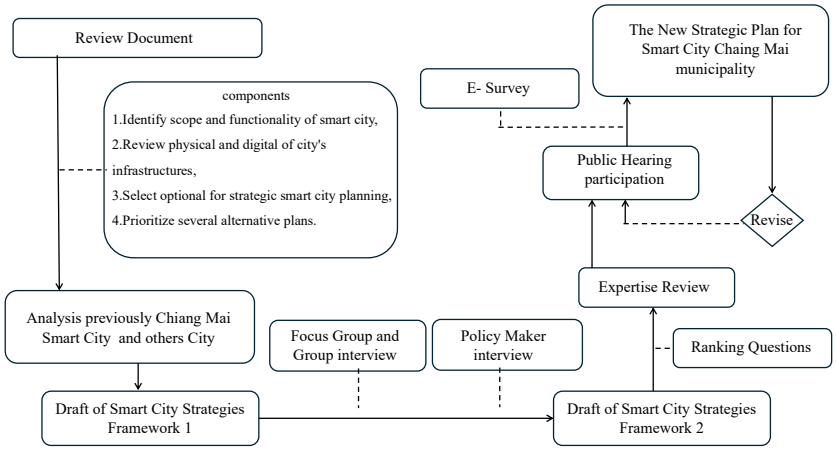

Figure 1 Research Methodology Framework .

Social engagement process

The Smart City of Chiang Mai Municipality is divided into two parts for the purpose of analyzing and evaluating its suitability for developing a strategic plan. These parts focus on enhancing smart energy and environmental initiatives through a social engagement approach. Step 1: Developing instruments for gathering data from the public sector within the specified region. This research will utilize a questionnaire as the primary

tool for data collection. Step 2 involves collecting responses from both the public sector and experts. The research is outlined as follows:

Development of Public Hearing Questionnaires: The design of the questionnaires was influenced by data pertaining to public perception and awareness of the Chiang Mai Municipality Smart City project. All documents related to data collection, including those for focus groups, group interviews, personal interviews, and questionnaires, were subjected to scrutiny and approval by scholars or experts [6]. The questionnaire consisted of three sections: Part 1: This section provided an overview of the statement's objective and sought to gather pertinent information for the project. Part 2: The survey gathered fundamental demographic data from the participants, including their gender, age, educational background, and occupation. Although respondents were encouraged to manually provide their names, anonymity was also preserved for those who desired it. Part 3 of the study involved collecting stakeholder perspectives and priorities on smart city strategies through the use of Likert scale questions. This section provided an opportunity for participants to share their viewpoints, beliefs, or factual information about their understanding or efforts concerning the smart city.

To collect data from both the general public and the expert group, we will use a comprehensive approach. This will involve using an online questionnaire to reach specific target groups within the Chiang Mai Municipality area. The process will entail the arbitrary selection of participants from the general population, guaranteeing a varied representation of demographics and perspectives. The expert group will adopt a focused strategy by directly inviting individuals who have been recognized as experts in relevant fields. The selection of these experts will be based on their proficiency in fields such as environmental science, technology, and policy-making, guaranteeing that their knowledge will aid in the creation of well-informed strategies and initiatives for the Smart City project. The online system will be created to streamline the gathering of data in a user-friendly way, enabling participants to offer feedback, opinions, and suggestions pertaining to the Smart City project. This approach aims to create a comprehensive dataset for the development of the Smart City of Chiang Mai Municipality. It will include perspectives from both the general public and experts, ensuring a well-rounded and inclusive development process.

Strategic verification

For Chiang Mai city, descriptive models based on practitioners, scholars, and subject matter experts were used to propose verification strategies. Heuristic models from traditional methods underpin conventional verification strategies. However, these models lack mathematical proof despite their past success. Purposive sampling, specifically Delphi, selected experts with expertise in five fields [7-8]. Selection of expertise requires four conditions. The leadership has local wisdom, advanced technology skills, and urban development experience. The expert has extensive smart city development experience. Mayors are prominent local leaders. The expertise excels in transportation, economy, energy, and innovation.

Data verification and triangulation are essential for ensuring the reliability and accuracy of questionnaire data during public hearings with stakeholders from different sample groups. A thorough evaluation process compares stakeholder responses and uses Cronbach's alpha to measure questionnaire item consistency to assess data reliability. Inter-rater reliability assessments determine stakeholder consensus in each group. To ensure data accuracy, stakeholder groups must cross-validate. Comparisons of data from multiple sources or methods, known as triangulation, validate findings and boost credibility. Comparative analyses identify response variations and similarities, while data cleaning ensures logical consistency and handles outliers. Descriptive statistics and correlation studies reveal questionnaire item averages and differences. This reveals stakeholder perspectives' relationships. Experts validate the questionnaire's

significance and precision in capturing a wide range of perspectives. Subject matter experts help ensure the questionnaire accurately captures stakeholder data. The questionnaire is refined iteratively using data verification feedback. This maintains data collection reliability and accuracy [9-12]. These data verification methods and triangulation techniques during public hearings provide strong, inclusive, and valuable information for making well-informed decisions and engaging stakeholders in Chiang Mai Municipality's Smart City project.

Result and Discussion

Strategic and the Initiatives

The goal of the Chiang Mai Universal Smart City is to guarantee and harmonize development using Lanna style and digital technology. The local government collaborates with the community to enhance efforts on the ground and tackle various concerns such as mobility, healthcare, education, environment, and other related areas. Enhance the efficacy of solid waste, sewage, and air pollution management to elevate the quality of services in the smart environment. Improve the quality and quantity of public spaces and green areas. It enhances environmental consciousness and advocates for the development of low-carbon cities. Enhance energy efficiency and promote the use of renewable energy sources. Advocate for the adoption of electric vehicles and the development of a supportive ecosystem [13 -14].

The initiative represents a detailed plan for the Smart City of Chiang Mai Municipality to improve smart energy and environmental projects, as indicated in Table 1. It includes 9 projects related to Smart Environment and 4 projects related to Smart Energy. Every initiative consists of Targets, Expected outcomes, and Key Performance Indicators (KPIs) as shown.

Table1 Strategic Plan and the Initiatives Program

	Initiatives	Targets	Expected outcomes	KPI
Smart Environment	P1 To improve Maekha Canal landscape	• Meakha canal	• Easy to access public space	• Percentage of satisfaction
	P2 To promote organic waste to composting	• Fallen leaf in communities	• Waste perception changed	• Increase percentage of fallen leaf • Number of community involvement
	P3 To collaborate for food waste management	• Hotel and restaurants	• Utility of food waste	• Amount of food waste
	P4 To improve and create Public Park nearby the Ping River	• Empty space in community	• New public park	• Percentage of green area in the city
	P5 To installing air monitoring station.	• Municipal area	• Air monitoring stations are converged	• Active air monitoring station
	P6 To rearrange GHGs emission management and resilience	• GHGs emission inventory	• Monitor GHGs emission at city as data base level	• city's policy brief on low carbon initiative
	P7 To Promote and create food security through waste management.	• Urban Food system in Chiang Mai	• Food policy	• City 's policy on food security
	P8 To Promote E waste management	• Communities	• E-waste containers are coverage in communities	• Percentage of e waste container
	P9 To Promote open space and green areas from digital utility	• Community space	• To manage youth and digital era	• Number of customers
Smart Energy	- P1 To install LED street lighting.	• Main street	• Replacement from Halogen to use LED	• Percentage of energy consumption
	- P2 To promote Electric Vehicles	• Car owner	• GHGs emissions reduction	• Reduces GHGs
	- P3 To support Charging station	• Main road in city center	• charging stations	• Number of stations
	- P4 To development and promote renewable energy	• Public Park and interlink area	• Renew energy use in public area	• Percentage of demonstration site

Public hearing responsibilities data

Data presentation and verification techniques guarantee the precision, uniformity, and dependability of data. This study employed a total of 501 samples or questionnaires. They play a vital role in this research, specifically in data analysis and database management. There were 215 males and 283 females who responded, making up 43.17 percent and 56.83 percent, respectively. Additionally, 0.60 percent did not specify their gender. The age distribution is as follows: 7.98 percent of the population is under 25 years old, 18.76 percent is between 25 and 35 years old, 27.35 percent is between 36 and 45 years old, 32.34 percent is between 46 and 55 years old, 11.98 percent is between 56 and 65 years old, and 1.60 percent is 60 years old or older. The level of education: The findings revealed that 51.10 percent of the individuals possessed a bachelor's degree, while 35.33 percent held a master's degree, with the remaining individuals falling into other categories. Regarding the habitat, it was discovered that 53.49 percent originate from Chiang Mai, while 46.51 percent do not reside in Chiang Mai province. The respondents can be categorized into five distinct groups: 49.10% are government representatives, 26.95% are tourists, 12.97% are from the business sector, 6.39% are from the general public, and 4.59% are from the educational sector. The data analysis revealed information regarding gender, age, education, and place of residence. The development of the Chiang Mai Smart City strategy does not have a direct impact. The researcher has taken into account and assembled representatives from diverse groups. Strive to become a pioneering factor in discovering additional connections.

The strategic development plan of Chiang Mai Municipality for smart cities in the smart environment will prioritize the expansion of public space and green space in the urban landscape. Enhance ecological variety and enhance the purity of the air Simultaneously, it offers an opportunity for community involvement. Additionally, it emphasizes the significance of enhancing environmental consciousness among residents and stakeholders through educational initiatives and community events to foster sustainable practices and conservation endeavors. Additionally, it facilitates the enhancement of waste management services. Management of wastewater treatment and air quality This is regarded as a crucial element of the plan. In the field of management, cutting-edge technology is employed to enhance productivity and minimize environmental contamination. By implementing these initiatives, Chiang Mai seeks to establish a more sustainable and habitable urban environment. It prioritizes the welfare of inhabitants and the preservation of natural resources.

The Smart Environmental Initiative prioritized the installation of air monitoring stations based on their proximity to the general population. This was followed by efforts to collaborate on food waste management and promote food security through waste management. Then there was a focus on prioritizing various initiatives, such as promoting open space and green areas through digital utility, managing E waste, rearranging GHGs emission management and resilience, promoting organic waste composting, improving and creating a public park near the Ping River, and enhancing the landscape of Maekha Canal.

The strategic development for the Smart City of Chiang Mai Municipality in Smart Energy involves a comprehensive approach to improving energy efficiency, promoting renewable energy, and encouraging environmentally friendly transportation. This initiative entails thorough data collection and analysis across various aspects. Firstly, data on energy consumption patterns will be gathered through surveys, metering systems, and utility records to understand trends and peak demand periods. Concurrently, information on existing energy infrastructure will be compiled to identify areas for optimization. Additionally, data on renewable energy potential will be collected through geographical mapping and resource assessments to pinpoint suitable locations for projects like solar installations and wind farms. Economic feasibility studies will also be conducted to assess the viability of renewable energy solutions. In terms of transportation, data on vehicle emissions, traffic congestion, and public transportation usage will be analyzed to gauge environmental impact and inform

strategies for promoting eco-friendly vehicles and improving public transit infrastructure. Commuting patterns and travel behavior data will also be scrutinized to identify opportunities for sustainable transportation initiatives. By leveraging comprehensive data analysis, the strategic development aims to inform evidence-based decision-making and guide the implementation of initiatives that enhance energy efficiency, foster renewable energy adoption, and create a more sustainable transportation system in Chiang Mai.

The key goal of the Smart Energy initiative is to enhance the utilization of sustainable energy sources, commencing with the implementation of LED street lighting in crucial locations. This is enhanced by the implementation of charging infrastructure to facilitate the increasing acceptance of electric vehicles, thereby aiding in the mitigation of carbon emissions and reducing reliance on fossil fuels. In addition, active measures are being taken to promote the utilization of electric vehicles within the city's transportation system, thereby advancing the shift towards sustainable mobility solutions.

Strategics Plan and Initiatives verification with expertise

Experts evaluating recommendations for the development of the Chiang Mai Smart Municipality found that they concurred with the public sector's view that the main focus should be on environmental development. and subsequently accompanied by the advancement of the energy sector in the area

Within the context of environmental development, it is imperative to enhance the aesthetic quality of the Maekha Canal and establish air monitoring stations to address existing issues. Additionally, efforts should be made to foster collaboration in managing food waste and reorganizing the management of greenhouse gas emissions and resilience. This includes promoting and establishing food security through effective waste management. Other from monitoring pollution levels in the vicinity, it is imperative to enhance and establish a Public Park in close proximity to the Ping River. This includes promoting the conversion of organic waste into compost and advocating for effective management of electronic waste, all with the goal of achieving In order to achieve sustainability, it remains imperative to persist in the promotion of open spaces and green areas through digital means.

Regarding Smart Energy, experts have provided their perspective on the advancement of urban areas through the establishment and endorsement of sustainable energy sources. In addition, they should encourage the implementation of LED street lighting and provide assistance for the establishment of charging stations. In order to advocate for the adoption of Electric Vehicles and encourage the utilization of alternative energy sources, which have the potential to significantly decrease emissions, particularly low emissions.

Experts have evaluated the suitability of developing the Chiang Mai Municipality Smart City in two phases: the short-term phase of 1-2 years will prioritize the enhancement of the Smart Environment by improving the quality of community waste management services, wastewater management, and air quality management. The main objective is to gather information about the current situation and utilize it for future planning and development of the city. The second phase, which is a medium-term time period of 3-4 years, will prioritize the development of both the Smart environment and Smart energy. The implementation of a smart environment involves the expansion of public and green spaces, the promotion of environmental consciousness, the transition towards a low carbon city, and the incorporation of smart technologies. The focus will be on enhancing energy efficiency and promoting the use of environmentally friendly vehicles to support the development of renewable energy.

Strategic verification with triangulation methodologies

Evaluating the suitability of the initiatives as a strategic approach for the development of Chiang Mai City Municipality Smart City will be evaluated by comparing the level of suitability derived from the data using the triangular comparison method. The evaluation will be based on information gathered through public sector feedback, expert opinions, literary documents and relevant research. This assessment will gather information from initiatives in each respective area. The Smart Environment category includes a total of 9 initiatives, while the Smart Energy category includes a total of 4 initiatives as listed in Table 1. Figure 1 (a) displays the data and comparison characteristics of the smart environment strategic initiatives, while Figure 1 (b) displays the data and comparison characteristics of the smart energy strategic initiatives.

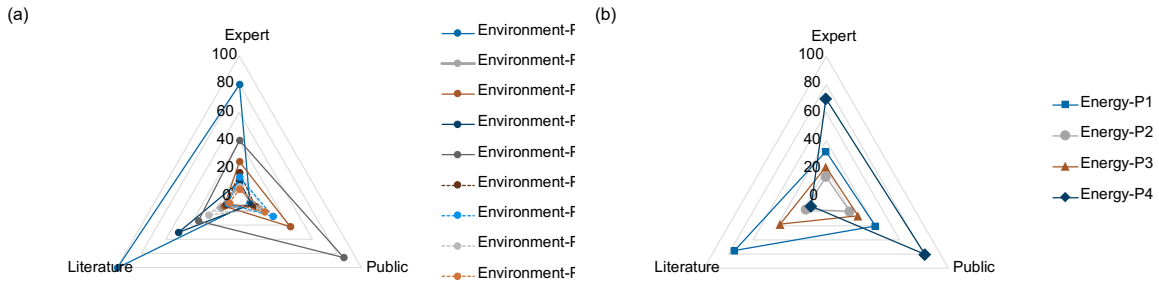

Figure 2 Triangular comparison of (a) the smart environment and

(b) the smart energy strategic Initiatives

Analysis of the Smart Environment triangular comparison data revealed a consensus among relevant literature and experts regarding suitable initiatives in the same direction. Prioritizing the development of the primary water sources in the region. Commencing with the enhancement of the Maekha Canal landscape, given its proximity to the local population and its significance as the primary water source. Regarding the general public, it is crucial to establish air monitoring stations as a primary means of tracking air impacts. These two initiatives are the initial projects being developed within the three datasets. Upon evaluating Smart Energy, it was discovered that the expert group held unanimous viewpoints that aligned with those of the public sector. Both groups reached a consensus that the primary emphasis should be placed on the initial development and promotion of renewable energy, as they both have a long-term perspective on this sector. Nevertheless, the literature suggests that our primary focus should be on enhancing energy efficiency or minimizing energy consumption initially. The proposed initiative is to implement LED street lighting as a means to decrease energy consumption. These two initiatives rank as the top two in all three datasets. Hence, the Chiang Mai Municipality Smart City development can be guided by four main projects, consisting of two projects focused on Smart Environment and two projects focused on Smart Energy.

Strategic Plan for Chiang Mai Municipality Smart City

The Chiang Mai Universal smart city development initiative project offers tangible solutions. The project will involve designing and implementing various activities to create the best model. The project will involve the collaboration between the government sector, private sector, and social support in order to establish a startup and foster cocreation. suggest There are two short-term development periods. The smart city development strategy of Chiang Mai Municipality will prioritize the implementation of Smart Environmental for Management initiatives over a period of 1-2 years. Municipal solid waste refers to the waste generated by households, businesses, and institutions within a specific area. Management of wastewater and air quality Highlighting the

enhancement of the Mae Kha Canal scenery. Through the means of The objective is to enhance the standard of the urban environment. and facilitate access to natural resources for individuals.

and medium-term growth and progress Over the course of 3-4 years, multiple strategies have been suggested to transform Chiang Mai into a city with a high standard of living. The Smart Environment Development Strategy aims to address urban problems by utilizing technology and innovation to achieve an effective and sustainable use of resources. Urban development initiatives aimed at expanding parks and green spaces within cities to enhance opportunities for recreational activities and educational experiences centered around nature. To improve the standard of living for residents and establish a city that achieves a harmonious equilibrium between growth and the environment. Security. The Smart Energy Strategy aims to promote the development and utilization of technology to enhance energy efficiency and optimize energy consumption. Minimizing energy consumption derived from fossil fuels and mitigating the release of greenhouse gases into the atmosphere. This research has received cooperation from all sectors, including the government sector, private sector, public sector, and education sector, in every process, from data collection, analysis, and synthesis, such as questionnaire testing, in-depth interviews, group interviews, and providing information via the E-Survey system, leading to the creation of plans and projects that are beneficial to the development of Chiang Mai as a smart city, focusing on promoting and initiating smart energy and smart environment projects of Chiang Mai Municipality. However, the research still faces some limitations, such as the public's thorough understanding of the smart city development process, including the participation and expression of opinions of the public in Chiang Mai Municipality, in order to be able to develop projects that truly meet the needs of the area and to strengthen cooperation in the development of a sustainable smart city in the future. However, the local government agency must establish a working group to monitor and evaluate, including the continuous allocation of budget for smart energy and environment management in the annual action plan.

Conclusion

The questionnaires, collected from the public sector, ensured diverse demographic representation. Chiang Mai Municipality's Smart City strategic plan prioritizes expanding public and green spaces to enhance ecological diversity and air quality in the smart environment sector. Residents and stakeholders are urged to actively engage in community activities promoting environmental awareness. The plan includes crucial elements like advanced wastewater management services to alleviate environmental pollution. The Smart Environmental Initiative aims to install air monitoring stations, manage food and electronic waste, and enhance the Maekha Canal landscape. In the Smart Energy sector, a comprehensive approach is taken to improve energy efficiency, promote renewable energy, and support sustainable transportation. Notable initiatives include LED street lighting and electric vehicle charging infrastructure to expedite the transition to sustainable energy and mobility solutions.

Expert evaluations align with the government's focus on environmental development, followed by energy advancements. Key environmental initiatives include enhancing the Maekha Canal, establishing air monitoring stations, and promoting food security. Experts advocate for sustainable energy sources like LED lighting and charging stations to decrease emissions. A progressive approach is proposed for building Chiang Mai Municipality's Smart City, starting with enhancing the Smart Environment in the short term (1-2 years) and progressing to both Smart Environment and Smart Energy domains in the medium term (3-4 years). This

approach aims to address environmental and energy challenges systematically, promoting sustainable urban development.

The analysis of the data from the Smart Environment triangular comparison shows that there is a general agreement among literature and experts when it comes to development initiatives. The main focus is on enhancing primary water sources, beginning with the Maekha Canal, owing to its close proximity and significance. It is essential to establish air monitoring stations in order to effectively monitor the impact of air pollution on the population. These projects are the first ones in each dataset. Unanimous support is received for the advancement of renewable energy through Smart Energy initiatives. Nevertheless, the literature recommends prioritizing energy efficiency as a primary focus. The proposed LED street lighting is in line with the highest priorities.

The Strategic Plan for Universal smart city development by Chiang Mai Municipality entails cross-sector collaboration. The primary focus is on implementing Smart Environmental Management, which includes efforts to enhance waste management and improve air quality. Over a span of 3-4 years, the strategies have the objective of increasing the quality of life by utilizing technology to achieve sustainable urban development. The Smart Environment Development Strategy prioritizes the development of parks and green areas, with the aim of balancing urban expansion and ecological preservation. The Smart Energy Strategy aims to concurrently improve energy efficiency and decrease reliance on fossil fuels, leading to environmental sustainability and enhanced living conditions. However, the local government agency must establish a working group to monitor and evaluate, including the continuous allocation of budget for smart energy and environment management in the annual action plan.

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