

# Integrating agenda setting and co-production: Governing smart environments in Chachoengsao, Thailand

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Received Mar. 3, 2025  
Revised Jul. 16, 2025  
Accepted Aug. 4, 2025  
Online Aug. 12, 2025

## Abstract

This research article analyzed the policy agenda setting and co-production of the smart environment in Chachoengsao Smart City, Thailand. The study applied a qualitative case study design, including semi-structured interviews with key informants from government, private, academic, and community sectors, as well as document analysis. Utilizing Kingdon's Multiple Streams Framework, the study found that rapid urbanization, environmental issues, strategic national policies, and political concerns brought attention to the policy agenda, creating a window of opportunity for smart environment initiatives through a top-down policy-making approach. This study also employed Loeffler's Four Co's Model to identify co-production activities. These were examined as bottom-up policy formulation efforts through co-commissioning, co-design, co-delivery, and co-assessment. The results demonstrated full co-production in which several stakeholders, including government, private, academic, and community representatives, strengthened their participatory governance and enhanced policy responsiveness for the smart environment. The process led to the implementation of the Zero Waste Initiative and Big Data for Environmental Monitoring, which enhanced community engagement, enabled data-informed decisions, and improved the effectiveness of environmental service delivery. Therefore, this article provides an understanding of collaborative governance and suggests that co-production serves as a strategic mechanism for achieving sustainable urban development. To encourage more open and adaptive governance in Thailand, further research should examine the possibility of applying co-production to other areas of the policy-making process.

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Published by ARDA.

**Keywords:** Collaborative governance, Multi-stakeholder participation, Smart City, Sustainable urban development, Policy process

## 1. Introduction

Urbanization accelerated during the 20th and 21st centuries due to significant population movements. More people relocate to cities for better opportunities and improved quality of life. This population shift toward urban areas has changed occupations, lifestyles, cultures, and behaviors, transforming the social and demographic structures of

both urban and rural areas. This urbanization affects the social aspects of living and working, especially in developing countries, where the trend continues to grow rapidly [1],[2]. According to the United Nations, urbanization is occurring rapidly worldwide, and by 2050, 70% of the global population will live in urban areas [3]. This rapid migration to urban areas causes cities to grow exponentially. However, public services and infrastructure are inadequate to meet the needs of the growing population. Unequal resource distribution leads to social inequalities, leading to adverse consequences such as environmental degradation, increased crime, and public health challenges. Therefore, managing cities is crucial for social development [4].

The Smart City concept has emerged as a key strategy for urban management to address these challenges and create more livable cities. This strategy aligns with Sustainable Development Goal (SDG) 11, which aims to "make cities and human settlements inclusive, safe, resilient, and sustainable" [5],[6]. The Thai government prioritizes Smart City development as part of the national agenda, driving the country toward a service-based and digital economy. The goal is to elevate Thailand to high-income country status and reduce socioeconomic inequality by 2036, as outlined in the 20-Year National Strategy, further supported by the Digital Economy Promotion Master Plan, a 20-year framework for Thailand's digital economic and social development. Smart City development is a significant focus under Strategy 4, which emphasizes building infrastructure for digital innovation. The goal is to create interconnected platforms that facilitate data sharing and provide open government data to support digital solutions [7],[8]. This effort enhances the efficiency of urban services and management through modern technology and innovation, strongly emphasizing good design and active participation from both businesses and citizens. Engaging the public is critical, as Smart City initiatives require citizen input and collaboration to ensure the solutions implemented genuinely address the needs of local communities [9].

A fundamental component of the Smart City is the "smart environment," which emphasizes reducing the environmental footprint and promoting sustainability through technology. According to the Digital Economy Promotion Agency (DEPA) [10], a smart environment is a mandatory component of Thailand's Smart City framework, meaning that each city must have initiatives to mitigate environmental impacts such as air and water pollution, waste disposal, disaster risk management, and natural resources protection. These initiatives incorporate smart technologies such as environmental monitoring systems, sustainable urban planning, and green infrastructure development to achieve higher sustainability and resilience. In Thailand, every designated Smart City must integrate smart environment initiatives into local policy development.

To implement the Smart City policy, the Thai government established the Smart City Development Steering Committee under Prime Minister's Office Order No. 267/2560, dated October 15, 2017. The committee formulated a policy and action plan divided into three phases: Year 1 (2018-2019), Year 2 (2019-2020), and Year 3 (2020-2022). In the first phase, seven pilot cities were selected, focusing on transforming 'existing cities' into more livable urban areas by integrating technology and innovation tailored to specific local needs. This included the development of infrastructure, utilities, housing, public spaces, employment, commerce, and urban planning while preserving each city's distinct culture, traditions, and identity. Chachoengsao Province, located in the Eastern Economic Corridor (EEC), was identified as one of Thailand's primary pilot cities. It successfully earned Smart City certification on October 28, 2021 (Figure 1).

Progress in Chachoengsao encompasses the economy, agriculture, tourism, sociocultural development, and water resource management. Chachoengsao's evolution to Smart City status involved shifts from a predominantly rural to a semi-advanced economy, built on agriculture with rice, fruits, and aquaculture as its cornerstones, alongside auxiliary industries. However, public services and urban infrastructure lagged far behind the region's potential. Furthermore, the province's proximity to Bangkok and major transportation routes did not benefit the area due to the lack of technology and an organized planning framework to sustain industrial growth. All these problems highlighted the need for large-scale transformation.

A vital component of Smart City development in Thailand is the active participation and coordination of multiple stakeholders. This aligns with collaborative governance, a public administration model under the New Public Governance paradigm that encourages all sectors to design public policies and services [11].

In this regard, the co-production concept has emerged as a powerful approach to collaborative urban management, which promotes the creation of public value through the collaborative development of urban policies and services [12],[13]. This approach emphasizes innovation and citizen participation, expanding urban development beyond government officials and experts to include voluntary contributions from other social actors, such as the private sector, the academic sector, and citizens [14]. Co-production takes place throughout the public policy cycle, encompassing co-planning, co-design, co-delivery, and co-assessment [15], ensuring that urban policies and services are tailored to the specific needs of each area [16],[17]. Moreover, co-production in urban development fosters greater acceptance of policies by encouraging the sharing of information, ideas, and decision-making responsibilities. This approach embodies the notion of a mature democracy, where citizen participation goes beyond simply providing information and involves active engagement in stages of the public policy process [18]. Therefore, this study aims to (1) examine the policy agenda setting for the smart environment in Chachoengsao Smart City, Thailand, and (2) explore the co-production process, including key actors and activities involved.

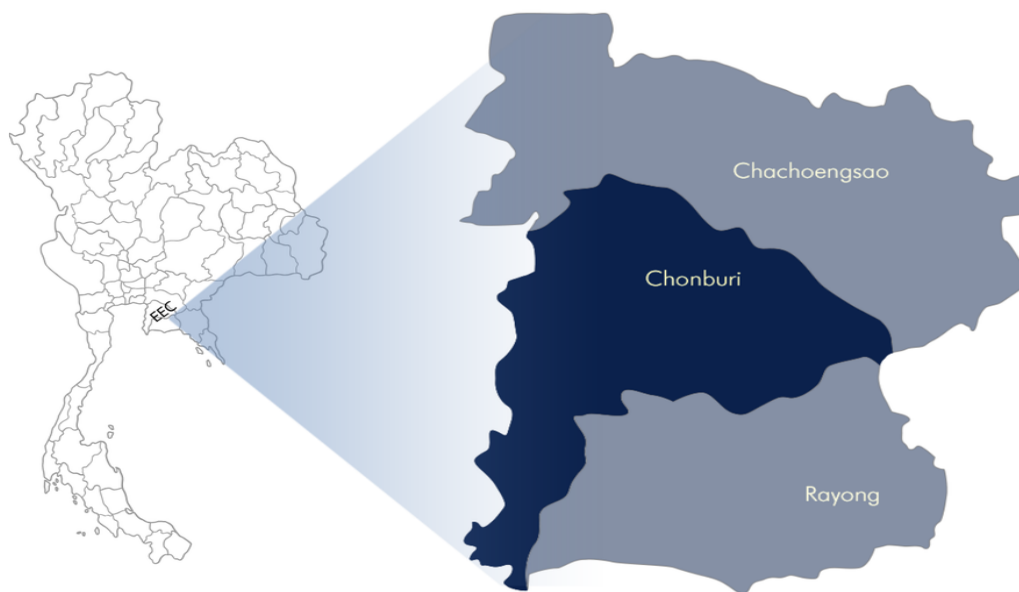


Figure 1. The location of Chachoengsao as part of the Eastern Economic Corridor (EEC), Thailand; Source: Adapted from Eastern Economic Corridor Office, retrieved from <https://www.eeco.or.th>

## 2. Research method

### 2.1. Conceptual framework

This study first applied Kingston's Multiple Streams Framework to examine how the smart environment policy developed in Chachoengsao by examining the intersections of three streams, which comprise the problem stream, the policy stream, and the political stream. This framework is highly compatible with this study as it offers a dynamic lens to examine how policy agendas emerge through the convergence of contextual factors. It has been widely applied across governance systems and is particularly adaptable to non-Western settings, where centralized authority and institutional uncertainty shape policy processes [19]. The analysis emphasized the role of local conditions and policy entrepreneurs in shaping policy outcomes. This approach helped identify critical factors influencing decision windows and demonstrated how diverse stakeholders shape urban policy [20],[21],[22].

For the second objective, this study applied the Four Co's Model [23] to examine co-production activities related to smart environment development in Chachoengsao. This model is theoretically appropriate for understanding collaborative governance, as it emphasizes the dynamic and multi-phase involvement of stakeholders throughout the policy cycle. It is particularly well-suited to Smart City contexts, where citizen participation and cross-sectoral engagement are essential for effective implementation. Co-production also strengthens inclusion and administrative trust when public institutions adopt participatory values and practices [24]. This part focused

on the collaboration between state actors (government officials) and non-government participants by investigating four main processes: co-commissioning for strategic planning, co-design for activities, co-delivery of services, and co-assessment of outcomes. This framework assisted in exploring how various stakeholders collectively contribute to the planning, executing, and evaluating smart environment to better understand participatory processes in urban development [25].

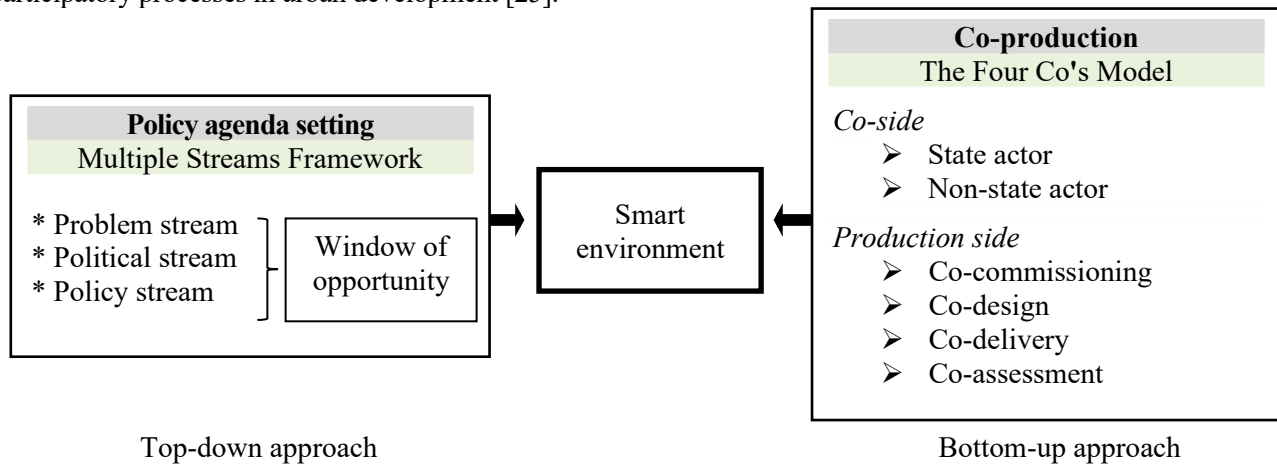


Figure 2. Conceptual framework

## 2.2. Qualitative research (case study approach)

This study employed a qualitative case study approach to collect comprehensive data aligned with the research objectives under a descriptive case study approach, focusing on the smart environment component of Chachoengsao Smart City, as outlined in the "Chachoengsao Livable, Tourist-Friendly, and Investment-Attractive City Plan." This methodology aligned with Creswell's perspective, which recognized a case study as a qualitative research technique designed to collect field data in a specific environment using various in-depth data collection tools such as observations, interviews, and document analysis [26]. Data were then analyzed and interpreted to produce in-depth findings that contributed to discovering new knowledge. Additionally, Yin suggested that case study research was appropriate when the research aimed to explore social phenomena by addressing "how" and "why" questions, offering a detailed and in-depth understanding of specific phenomena [27].

## 2.3. Selection of key informants

This study initially employed purposive sampling, which is appropriate for qualitative research focusing on specific issues [28],[29]. Informants were selected using a criterion-based sampling technique to ensure alignment with the study's objectives [30]. This approach involved selecting key informants who were actively engaged in the smart environment under Chachoengsao's Smart City Development Committee.

After the initial selection, additional participants were identified using the snowball sampling technique, as recommended by earlier informants. To ensure a comprehensive dataset, the study initially aimed to include more than five key informants, adhering to the recommendation for a case study by [31]. Ultimately, eight informants were recruited, with data saturation and redundancy achieved. Informants were categorized into two groups: (1) state actors from government agencies involved in smart environment development, and (2) non-state actors from various non-governmental sectors. To ensure confidentiality, each key informant's data were pseudonymized by replacing names with coded identifiers (see Table 1).

Table 1. Summary of key informants in the study

Code	Role of key informant	Gender
Key informant 1	Deputy Director of Central Business District and Smart City Division, Eastern Economic Corridor Office	Male
Key informant 2	President of Smart City Promotion Department	Female

Code	Role of key informant	Gender
Key informant 3	Head of Chachoengsao Smart City Office	Male
Key informant 4	Secretary to Chachoengsao Smart City Office	Female
Key informant 5	Chachoengsao Smart City Committee (academic sector)	Female
Key informant 6	Chachoengsao Smart City Committee (private sector)	Male
Key informant 7	Chachoengsao Smart City Committee (civil society sector)	Male
Key informant 8	Chachoengsao Smart City Committee (community representative)	Male

All informants were directly involved in the smart environment development under the Chachoengsao Smart City initiative.

#### 2.4. Research instrument

This study combined fieldwork and document analysis methodologies. Primary data were collected through informal, in-depth interviews using a semi-structured interview guide. The interview questions were designed to enable key informants to prepare and tailor their responses based on their specific contexts.

Additionally, relevant documents were reviewed, including primary sources (laws, regulations, and official government records) and secondary sources (such as operational reports).

Instrument validity was ensured through a preliminary evaluation by a panel of at least three experts, including the research advisor. Prior to data collection, the finalized research questions were submitted for approval to the Committee for Research Ethics (Social Sciences) at the Faculty of Social Sciences and Humanities of Mahidol University, Thailand.

#### 2.5. Collection of data

Key informants were contacted via email or phone and invited to participate in face-to-face interviews at a mutually convenient location. The interviews were conducted between July and September 2024. Each session lasted approximately 30 to 45 minutes. Participants received an information sheet, consent form, and interview questions at least one week prior to the interview.

#### 2.6. Data analysis

This study employed a within-case analysis to generate in-depth findings from Chachoengsao as a single-case study [32],[33]. A combination of directed content analysis [34],[35] and interactive analysis [36] was used to explore the phenomena under investigation.

In the first phase, directed content analysis was applied using pre-established categories derived from the study's conceptual frameworks. For the analysis of policy agenda setting, categories are structured according to Kingdon's Multiple Streams Framework, emphasizing key decision-making moments. Subsequent coding applied Loeffler's Four Co's Model to categorize co-production activities.

Following the initial coding, interactive analysis was conducted to refine and explore relationships within the data [37]. This process involved uncovering patterns and interactions among stakeholders involved in the smart environment development of Chachoengsao. This phase allowed for flexible data interpretation, ensuring that conclusions were firmly rooted in the case study's context.

### 3. Results

#### 3.1. The policy agenda setting of the smart environment in Chachoengsao Smart City, Thailand

Understanding the three streams provides insight into the driving factors behind smart environment policy formulation in the case study. In this section, the researcher presents the results from interviewees at both the macro-policy level, including the Eastern Economic Corridor (EEC) Office and Digital Economy Promotion Agency, and the micro-policy level, represented by the Chachoengsao Smart City Office staff. Examples of interview quotations are also included in the text to explain the findings.

### 3.1.1. Problem stream: The result of urbanization and backward public administration

Key informants consistently reported that urbanization in Chachoengsao Province was driven by its strategic role within the Eastern Economic Corridor, intensified pressure on infrastructure and environmental resources, particularly following the enactment of the Eastern Special Economic Zone Act of 2017. Between 2020 and 2022, the population grew from 720,718 to 726,687, with a growth rate rising from 0.08% to 0.35%, contributing to a density of 135.78 persons per square kilometer. This urban expansion posed significant challenges for public administration, particularly in addressing housing needs, delivering public services, and ensuring sustainable urban management. One of the participants expressed the following:

*"As a Chachoengsao Smart City Office member, I think the administrative system needs to adapt more quickly to manage our urban growth effectively. If it is too slow or no action is taken, it will not be able to handle infrastructure and environmental problems properly." (Key Informant 3)*

Another piece of evidence from an annual report by the Chachoengsao Statistical Office also showed that severe environmental challenges existed with the rapid growth of urbanization and industrialization. The province produced an average of 109,003.05 cubic meters of wastewater per day in 2022, compared to 108,626.7 cubic meters in 2021. However, only 19.98% (approximately 21,781 cubic meters) of the wastewater was adequately treated, leaving a massive amount of untreated wastewater polluting the rivers. Moreover, the Water Quality Index (WQI) from 2020 to 2022 illustrated a decrease in the dominant water source, which indicated environmental deterioration. Tha Khai Canal in 2022 scored 46.3, and the Phan Thong Canal in 2022 scored 37.90. Both canals were classified as "poor" in quality. Even the Bang Pakong River, the main waterbody of the province, showed a downward trend with WQI scores of 61.67 in 2020, 63.24 in 2021, and 62.50 in 2022, nearing poor conditions. This study further found that solid waste management is still one of the primary issues in the case study. The province contributed 771 tons of municipal solid waste daily in 2021; the total appropriate waste management was only 276 tons. Out of the total generated waste, 352 tons were reported to be dumped, and 143 tons were reported to be recycled or reused. The grossly unmanaged waste demonstrates a significant infrastructure deficit that further adds to environmental degradation. Air quality is another major problem, and the amount of PM<sub>2.5</sub> in the air exceeds the threshold limit for 45 days a year, particularly from December to March. The combination of stagnant weather conditions and burning in farming areas worsens this seasonal pollution. The public complaint data also contributed to the understanding of environmental issues. In this regard, from 2016 to 2022, the most significant number of complaints by far dealt with air pollution (108 cases), followed by wastewater problems (88 cases) and odor (72 cases). Other complaints about the governance regulations dealing with dangerous materials (32 cases) and solid waste (22 cases) are also related. One of the participants pointed out the following:

*"Our city now has many environmental problems, such as wastewater, solid waste, and air pollution, but the resources to deal with them are limited. The complaints are already coming in, and it is evident that we need the functional concept to deal with things fast enough." (Key Informant 7)*

The study also revealed that urbanization has contributed to increased human-wildlife conflicts, mainly regarding wild elephants. Because of the expansion of urban and agricultural land, forest reserves and habitats are invaded, leading to less food for elephants and forcing them to invade farmlands. The increasing need for land for industrial and housing constructions tends to fuel this invasion, as one key informant stated:

*"More houses and factories result in fewer forests and fewer habitats. The elephants have nowhere to go, so they come to farms. This is also a main issue across the surrounding provinces, not just us. So, our team [Chachoengsao Smart City Office] seeks collaboration from inside and outside partners to design the platform to resolve this urgent situation." (Key Informant 4)*

### 3.1.2. Policy stream: Influence by direction of national policy reform

Interview findings indicate that national policy reforms were pivotal in advancing Smart City development in Thailand, including the smart environment as one of the requisite parts of this advancement. As the primary

policy entrepreneur, the Thai government significantly shaped the direction of the national development strategy under the 20-year National Strategy. This framework justified the policy agenda because it accompanied fundamental goals for establishing the country's development direction.

The concept of a Smart City was first introduced in 2003 by the Ministry of Information and Communication Technology (now called the Ministry of Digital Economy and Society). However, as several key informants noted, limited progress occurred until the implementation of the Thailand 4.0 policy in 2016. "Stability, Prosperity, and Sustainability" served as the vision for this policy, which served as a driving force in reshaping Thailand's growth strategy for the 21st century. One of them expressed the following:

*"Thailand 4.0 is a turning point for Smart City, shifting the focus from traditional production to leveraging technology and innovation to create more sustainable, environmentally conscious cities." (Key Informant 1)*

The above policy was further aligned with the 20-year National Strategy, which aimed to transform Thailand's economy from middle-income to high-income. This elevation was supported by the Digital Economy and Society Development Act of 2017, where the Office of Digital Economy Promotion was established to formulate digital economy and society development plans and policies under Strategy 8 of the 13th National Economic and Social Development Plan (2023–2027), which emphasizes innovation, sustainability, and inclusivity in urban development. This strategy focused on creating a Smart City that was economically prosperous, safe, and provided good public services, as one participant noted:

*"This goal strives to drive economic development in the country, draw investment into the special economic zone (EEC), diminish disparity, and foster urban sustainable development that improves residents' quality of life. Furthermore, this strategy will also enhance interagency cooperation between the government, private sector, civil society, and local communities towards urban and regional development." (Key Informant 1)*

The Digital Economy and Society Development Act of 2017 was also mentioned during the interviews. In Chapter 5 of the Act relating to promoting the digital economy, Section 35 (1) mandated the establishment of the Digital Economy Promotion Agency (DEPA), which became the primary institution for devising strategies to meet national digital policies. Hence, the Master Plan for Promoting the Digital Economy (2018-2022) was announced. In this regard, strategy 4 introduced the Smart City project, which aimed at establishing a digital infrastructure for urban innovation and the interconnection of data across urban systems.

Later, the Smart City Thailand Office was established under DEPA through Order No. 1/2019 in alignment with these reforms. The primary responsibility of this office was to develop master plans, operational frameworks, and mechanisms to drive Smart City initiatives nationwide in action. According to the order, a Thailand Smart City was officially defined as: *"A city that utilizes modern technologies and innovations to enhance urban management, service delivery, and quality of life, cost and resource savings, life quality enhancement and happiness of the populace while promoting a partnership of the private sector and people under the concept of livable, modern and sustainable metropolitan development."*

### **3.1.3. Political stream: Pilot area designation because of administrative decision-making**

Interview findings indicate that Smart City development in Chachoengsao was supported by Prime Minister's Office Order No. 267/2017, issued on October 15, 2017, establishing the Smart City Development Steering Committee. This committee was chaired by the Deputy Prime Minister, who was tasked with formulating strategies and master plans for the 20-Year National Strategy and Thailand 4.0 Policy.

Subsequently, on March 8, 2019, the committee issued Declaration No. 1/2019, which defined the evaluation criteria, qualifications, methods, and procedures for Smart City designation. This declaration clarified the "smart environment" as: *"A city that mitigates environmental impacts by systematically applying technology to manage natural resources, such as water management, air quality control, waste reduction, and sustainable conservation of natural resources."* Consequently, a smart environment was a prerequisite component for earning the title of a Smart City in Thailand.

Furthermore, Chachoengsao was designated as a pilot area for the first phase of Thailand's Smart City development program because of its strategic location in the Eastern Economic Corridor (EEC) and the presence of significant environmental challenges, as one key informant stated:

*"The Prime Minister set up the steering committee. Then, this committee defined relevant components that served as boundaries and provided clarifications. Everything was set for implementation...and since Chachoengsao is part of the EEC, it was naturally selected as a pilot city without hesitation." (Key Informant 2)*

These findings illustrate how a policy window for the smart environment in Chachoengsao emerged through the convergence of the three streams. First, the problem stream was revealing. A significant increase in urban development along the Eastern Economic Corridor resulted in several environmental problems. At the same time, the policy stream was already in motion. National policies such as Thailand 4.0 and the 20-Year National Strategy promoted the construction of the Smart City concept and mechanism to foster those initiatives. Finally, within the political stream, the Smart City Development Steering Committee designated Chachoengsao as a pilot city because of its geo-strategic considerations and critical environmental issues.

### **3.2. The co-production of the smart environment in Chachoengsao Smart City, Thailand**

This section examines the micro-level co-production activities that shape the smart environment in Chachoengsao following its designation as a Smart City at the macro-policy level. It draws attention to the participation of different actors and essential processes within the four components: co-commissioning, co-design, co-delivery, and co-assessment. To indicate these dynamics, selected quotations from key informants are delivered to demonstrate their experience, position, and contributions toward the co-production approach.

#### **3.2.1. Co-commissioning**

The study found that relevant activities encompassed key themes of collaboration, including the co-planning of strategies, co-prioritization of outcomes, and co-financing of projects and services.

As the first step, the co-planning of strategies was initiated after Chachoengsao Province was chosen as one of the pilot Smart Cities under the national scheme. In this regard, the provincial governor signed Provincial Order No. 410/2021, which appointed the Smart City Development Committee for Chachoengsao Province. This committee included stakeholders from the public sector, private sector, and even academic and community representatives who were collectively invited to assist in designing and developing the city's vision, goals, and long-term development plan. Additionally, the Chachoengsao Smart City Office was established under Provincial Order No. 1784/2021 as an operational secretariat of the committee to coordinate the strategic plan and ensure that public and private sector investments meet the city's objectives.

With stakeholder input, the vision was completely established: *"Chachoengsao is a livable, comfortable city where citizens are happy, prosperous, and sustainable."* Along with the stated vision, four strategic goals were then set for the smart environment, consisting of (1) maintaining a clean and safe environment, (2) managing waste and pollution effectively, (3) balancing urban development with sustainability, and (4) enhancing environmental monitoring and management, respectively. These goals stemmed from formal consultations, which aligned local expectations with national objectives. Representatives of the key informants stated the following:

*"We [Committee] don't just draft a plan in a meeting room and announce it. We held consultations, asked for opinions, and refined the goals based on what people thought was important. The idea was to align national policies with what works locally, not just follow a top-down approach." (Key Informant 4)*

*"When discussing the vision and strategic goals for the smart environment, it can't just be done by one group alone. We must look at everything together because nature, urban development, and the economy are all connected. That's why the committee brought different sectors to be part of the planning committee...the government understands policies, academics can assist with technical expertise, businesses focus on investment, and the community gives us real, on-the-ground insights." (Key Informant 5)*



As noted, the strategies provided a basis for prioritizing outcomes, which were then formulated into projects. The finding revealed that out of the seven proposed projects, the assessment and ranking were conducted through several means, such as voting, impact evaluation, and provision of arguments in a free forum discussion. The academic and private representatives provided most of their input on these projects' technical analysis and operational planning. In contrast, community representatives had to ensure the proposed solutions were practical by identifying local issues. Public sector officials managed the process to ensure they were within the relevant policies and guidelines. As stated: *"Yes, our team [committee] didn't just pick projects randomly. Every project had to go through a proper review process to figure out what should come first."* (Key Informant 8)

After that, the execution of these prioritized projects depended heavily on co-financing, which was facilitated through multi-sectoral collaboration. A vital resource from The Bang Pakong Power Development Fund, established under the Energy Industry Act 2007, supports projects to mitigate environmental impacts in areas near power plants. Simultaneously, industrial enterprises in Chachoengsao contributed financial resources and technical expertise as part of their Corporate Social Responsibility (CSR) programs, whereas the Smart City Office of Chachoengsao ensured that these resources were used more effectively by proper coordination to meet the city's strategic goals. As one participant claimed:

*"Luckily, most projects got support from the Power Plant Fund since they were carried out in communities affected by electricity production, so we saw an opportunity to apply for funding. Plus, we have a lot of industries here, and provincial leaders worked with them to secure free support such as equipment, funding, or technical knowledge. It is a way for the companies to give back to the community while using the Smart City initiative as a testbed for their new technologies and innovations."* (Key Informant 7)

### 3.2.2. Co-design

The finding revealed that co-design can be defined under the theme of co-developing and shaping public projects and services, operated via two distinct approaches. Some projects emphasized active community participation, while others relied primarily on specialized technical expertise due to the project's complexity.

On the community-focused side, the Zero Waste Initiative in Tha Kham Subdistrict, Bang Pakong District, can perfectly highlight the mirror of local citizen involvement in the co-design. This project aimed to create a waste-free zone by applying advanced waste separation technologies. Residents played an active role by contributing practical suggestions on waste management practices. For instance, they provided feedback on methods for separating organic and recyclable waste and helped shape materials to ensure accessibility. This collaboration, facilitated by public officials and supported by academic experts, ensured that the initiative was reflected in the community's needs. In this case, the co-design fostered a sense of ownership and accountability among community members, which is critical for the project's long-term sustainability.

*"I can share the experience from participating in this project. Residents got a chance to share ideas, gave feedback on properly separating waste, and even ensured that processes were easy for everyone to understand. I felt good to be part of something supporting our community."* (Key Informant 8)

On the contrary, several projects required significant technical expertise and were designed primarily by government sectors, private sectors, and academic institutions. For example, the Big Data for Environmental Monitoring project utilized advanced analytics to monitor air and water quality, requiring collaboration among experts to design systems capable of processing large datasets and generating actionable insights. Similarly, the Wild Elephant Alarm System, developed with support from True Corporation, an external private company, utilized IoT sensors to detect and alert communities about wild elephant movements, with the design phase led by telecommunications and technology specialists. Another example is the Smart Environment Innovation Center (ENIC), established in partnership between Tha Kham Municipality and Chulalongkorn University, which served as a hub for environmental innovation, mainly shaped by academic know-how. One of the participants expressed:

*"Some projects need expert knowledge, like air and water quality monitoring, so local people will not be directly involved in the technical part."* (Key Informant 7)

### 3.2.3. Co-delivery

The study found that the co-delivery of services was a fundamental component in the success of the smart environment in Chachoengsao Smart City. This collaborative approach combined the strengths of co-management and co-performing by balancing technological expertise with stakeholders' engagement to jointly manage and deliver relevant projects as public services.

Co-management of public facilities was essential for projects that relied heavily on advanced technologies and required ongoing maintenance and oversight. The Chachoengsao Smart City Office played a central role in ensuring that these projects adhered to national policies and budgetary regulations while meeting the city's environmental goals. One notable example was the Big Data for Environmental Monitoring Project, a collaboration with the Faculty of Engineering, Chulalongkorn University. This project integrated data systems for monitoring water quality, air quality, and waste management. It used innovative tools such as predictive models for air quality forecasting and Circular Economy principles to address waste challenges comprehensively.

In addition to big data management, environmental monitoring stations were a key feature of co-management efforts. Ten air quality monitoring stations were installed across strategic locations, including Blue Tech City Industrial Estate, Bang Pakong District Office, and Tha Kham Subdistrict Municipality. Five of these stations were managed by local governments and industrial stakeholders, while the remaining five were operated in collaboration with Chulalongkorn University. Similarly, water quality monitoring stations were co-managed in Phan Thong Canal and Tha Kham Municipality, providing real-time data critical for water management. These projects demonstrated how stakeholders of the public, academic, and private sectors worked together to sustain technological infrastructure. One of the key informants expressed the following:

*"Most of our smart environment projects need experts to set up the system, but after that, we all still have a role in maintaining them. Local governments and industries took charge of some stations, while the university helped with the analysis. It's a shared responsibility." (Key Informant 4)*

On the other hand, the co-performing of services by users (local residents) was exemplified in the Zero Waste Initiative project, a pilot program implemented in the Tha Kham Subdistrict. Residents actively delivered public services by participating in waste segregation at the household, school, and community levels. Organic waste was collected and processed into compost, reducing landfill dependency and creating economic value for the community. This grassroots participation was supported by community leaders, including village chiefs (called Kamnan in the Thai language) and village committees, who provided training, raised awareness, and motivated residents to engage in sustainable waste management practices. Their leadership fostered a strong sense of ownership among community members, ensuring the initiative's success.

Moreover, this project also benefited from institutional partnerships facilitated by the Chachoengsao Smart City Office. A Memorandum of Understanding (MoU) was signed with partners such as Rajabhat Rajanagarindra University, the Thai Bioplastics Industry Association, and the Blue Tech City Industrial Estate Development Project. This partnership aimed to integrate science, technology, and innovation into the initiative under the Bio-Circular-Green Model. The collaboration enhanced local capacity and resilience, supporting the community in adopting sustainable practices over a five-year implementation period. One key informant noted:

*"It's about real collaboration where the local government, experts, and the community, especially the people, contribute to improving the project together." (Key Informant 7)*

### 3.2.4. Co-assessment

The study revealed that co-assessment activities were pivotal in fostering public participation and ensuring the accountability of the smart environment. These activities enabled residents and stakeholders to evaluate and improve public services through structured feedback mechanisms and collaborative research efforts. One of the key findings was the active role of the "LINE OA @8riewsmartcity" platform in enabling feedback to public service providers.



This platform served as a centralized hub for environmental data, providing real-time air and water quality updates and functioning as a public participation communication medium. Through its integrated "Damrongdhama Center" on the mobile application, residents could raise complaints, share feedback, and suggest improvements regarding ongoing projects. The chat function allowed users to report specific issues, enabling the Chachoengsao Smart City Office to respond promptly. For instance, one participant stated: *"I used to report a problem status with an air monitoring station. The office [Chachoengsao Smart City Office] resolved the issue within 2 days, and I received message updates on the progress."* (Key Informant 8)

In addition to direct feedback, joint research emerged as a significant component of co-assessment. The Chachoengsao Smart City Office, in collaboration with Rajabhat Rajanagarindra University, initiated studies to evaluate the effectiveness of projects such as the Zero Waste Initiative. These research projects targeted key stakeholders, including residents, private businesses, and local organizations, to assess the outcomes and identify areas for improvement. For example, surveys were conducted to understand residents' challenges in implementing waste segregation practices and the benefits of composting organic waste, as stated: *"The university is a partner with the Smart City Committee, and as an academic provider, our role is to deal with data from local people's feedback, which is crucial for refining project designs and ensuring they align with the real needs of the community."* (Key Informant 5)

Based on the results, it can be stated that co-production is present in Chachoengsao's smart environment, bringing together the government and non-government actors who co-commission to achieve goal setting and planning that balance national policies with community problems. After that, co-design allowed residents to shape the related local project while experts handled more technical solutions. In addition, co-delivery ensured that all stakeholders were engaged in the activities. Finally, co-assessment provided a means to enhance the projects with respect to public comment and research. This is an illustration of how the co-production model changed concept into practice.

A summary of findings from policy agenda-setting and co-production from the case study is summarized in Figure 3, providing a comprehensive overview of the research results.

## 4. Discussion

This study seeks to understand the intersections of environmental concerns, policy instruments, and political support, creating a window of opportunity towards a smart environment in Chachoengsao Smart City. The study draws from Thailand's national policies to analyze these three streams and co-production phenomena in the context of Chachoengsao's smart environment. The following sections provide an exploration of these findings.

### 4.1. Problem, policy, and political streams: Creating a window of opportunity

Chachoengsao is at a crucial moment where environmental challenges, policy frameworks, and political support align, creating a policy window for Smart City development. The city faces severe environmental pressures, including pollution, inadequate wastewater treatment, and deteriorating air quality, necessitating structured interventions. This context is consistent with findings that urbanization-induced environmental degradation is often exacerbated by poor waste management, insufficient policy enforcement, and inadequate stakeholder participation [38],[39],[40].

Similar challenges have been addressed in cities such as Beijing, where policy-driven interventions leveraging technology and governance reforms have been used to manage urban congestion, energy consumption, and pollution [41]. Research further suggests that integrating smart policies with technological solutions is critical to sustainable urban transformation. For instance, China's Smart City Pilot Policy successfully reduced carbon emissions by 4.36 percent through industrial restructuring, improved environmental monitoring, and clean energy adoption [42]. Likewise, Poland has demonstrated the value of smart energy and transportation systems, reinforcing the role of policy coordination and governance innovation in addressing urban sustainability [43]. These cases highlight the necessity of integrated policy frameworks and strategic urban planning for tackling environmental challenges in Chachoengsao.

Thailand's national strategies, including Thailand 4.0, the 20-Year National Strategy, and the Digital Economy Promotion Master Plan (2018–2022), provide a strong foundation for sustainable and technology-driven urban development [44]. These policies align with findings that national-level policy alignment is essential for Smart City success by enabling institutional integration and regulatory support [45]. However, policy adaptation is context-dependent and requires tailored governance approaches rather than direct policy transfers. Countries such as Hungary and the Netherlands have demonstrated that institutional adjustments and localized implementation strategies are critical for effective policy adoption [46]. Similarly, a study by [47] emphasized that government capacity, economic incentives, and cross-sector collaboration are decisive factors in ensuring the success of Smart City policies. Chachoengsao's participation in the Smart City Thailand Initiative strengthens its alignment with national and regional efforts, facilitating policy refinement through shared lessons from ASEAN Smart Cities Network (ASCN) partners [48].

There is an indication that political leadership is significant in advancing Chachoengsao's smart environment, particularly through the Prime Minister's Office Order No. 267/2017, which links national Smart City policies to local implementation. According to Kingdon's Multiple Streams Framework, strong political will is essential for translating policy ideas into actionable outcomes. This finding is consistent with research emphasizing that effective Smart City implementation depends on sustained political support and cross-sectoral leadership [49]. The impact of political leadership is evident in Chachoengsao, where policy direction and administrative commitment have shaped Smart City initiatives. Studies suggest that policy implementation depends on inter-agency coordination and administrative efficiency [50], while long-term success requires policy continuity [51]. In contrast, weak governance structures have stalled progress in cities such as Dhaka, where fragmented regulations and poor inter-agency coordination have delayed Smart City development [52].

#### **4.2. Full co-production in smart environment development**

While the policy agenda-setting provides an opportunity for smart environment development, the effectiveness of this project depends on collaborative governance. In this context, the findings suggest that Chachoengsao exemplifies full co-production, where several actors from the government sector, private sector, academic sector, and community representatives collaboratively engage in the entire process of planning, design, delivery, and assessment to ensure that urban policy and services are formulated and implemented relating to all interests [53]. This approach reflects what full co-production is, which differs from partial co-production in the level of engagement of the stakeholders. In the case of partial co-production, citizens participate only in the implementation or consultation phases, but in full co-production, there is joint responsibility and decision-making in all stages [54]. Unlike traditional top-down policymaking, full co-production ensures stakeholders contribute and participate as co-deliverers of urban services [55], as Chachoengsao is evident in several key areas:

##### **4.2.1. Co-commissioning**

Chachoengsao's participatory approach reflects a broader movement towards participatory governance in Smart City planning, where public, private, academic, and community stakeholders collectively shape policy priorities. This is consistent with [56] argued that participatory governance in Smart Cities enhances decision-making efficiency and policy legitimacy. The city's impact-based ranking system, which prioritizes smart environment projects based on citizen needs and sustainability objectives in the case study, aligns with best practices observed in many European cities [57]. Furthermore, the reliance on diversified funding sources, such as the Bang Pakong Power Development Fund and Corporate Social Responsibility schemes from industries within the province, demonstrates the role of financial collaboration in sustaining long-term urban development [58].

##### **4.2.2. Co-design**

Chachoengsao has integrated community knowledge with expert-driven planning to ensure citizen participation in a smart environment project. This process aligns with [59] highlights that citizen-driven initiatives enhance urban sustainability by focusing on local citizen perspectives in environmental sustainability projects. The Zero Waste Initiative, for example, illustrates how residents have played a direct role in shaping waste management

policies. However, barriers remain, as technical complexity in large-scale projects can limit direct local citizen involvement [60]. This echoes the findings of [61] argued that public participation in Smart City development is often constrained to later implementation phases, necessitating more inclusive co-design methodologies.

#### 4.2.3. Co-delivery

Multi-sectoral collaboration in service provision is crucial to Chachoengsao's smart environment. The Big Data for Environmental Monitoring project is a prime example of a project where provincial and local government, private sectors, and academic institutions collaborate to manage environmental data for evidence-based policymaking. This approach is supported by [62] emphasized that multi-stakeholder data-sharing mechanisms improve the effectiveness of urban governance. Similarly, the Zero Waste Initiative highlights the role of citizen-led service delivery, reinforcing findings from [63],[64] that citizen engagement in municipal environmental management will significantly enhance pleasant urban environmental outcomes. As [23] noted that institutional coordination further strengthens governance, and cross-sectoral collaboration is key to optimizing public service delivery.

#### 4.2.4. Co-assessment

Chachoengsao's integration of real-time public feedback mechanisms through digital platforms such as LINE OA @8riewsmartcity exemplifies how co-production enhances policy responsiveness and transparency. This is consistent with [65] highlights that digital engagement tools strengthen citizen trust and accountability in Smart City governance. Additionally, collaborative research between the Smart City Office and Rajabhat Rajanagarindra University contributes to data-driven policy evaluation, aligning with [66], who emphasized that co-production in public administration fosters adaptive governance through ongoing policy refinement. The significance of scientific co-production in environmental governance has been widely recognized. Studies by [67],[68] argued that collaborative assessment frameworks enhance urban sustainability by integrating expertise with community-driven priorities.

This article contributes to the literature on Smart City governance in the Global South by highlighting the need to balance between inclusiveness and local contextualization. As [69] indicated, partnership, participation, and communication are essential to the effectiveness of Smart City programs in Thailand, although limited institutional capacity often challenges the attainment of transparency. Moreover, a case study from Iraq [70] on cultural heritage highlighted how the participation of youth and marginalized groups strengthened community ownership and sustainability. While examined in different contexts, both studies advance the concept of inclusive governance that empowers local and community-based action. Smart City development in emerging economies is informed by the need to emphasize adaptable governance frameworks that integrate multiple levels of stakeholders. Chachoengsao demonstrates how informatics can enable citizens to provide feedback and participate more actively. This relates to the open government concept, where technology is applied to enhance trust, as well as accountability and governance. The case of e-participation in Jakarta illustrated this point, as it offered safer and more convenient methods of participation than traditional approaches, especially in contexts with rigid social hierarchies. These examples demonstrate that to encourage active public participation in Smart City governance, it is essential to move beyond an innovation-centric approach to incorporate social inclusion. [71],[72].

While Chachoengsao shows strong potential for full co-production, it remains limited by Thailand's system and culture regarding co-production. The designation of Chachoengsao as a Smart City resulted from a centralized, top-down decision process that severely restricted local flexibility and autonomy [73]. Socially rooted patterns of respect for hierarchy make open conversation more challenging, particularly in the countryside [74]. A blend of these cultures with inflexible systems and unequal power dynamics limits opportunities for shared trust and responsibility [75]. Gaps in economic classes also determine the active participants, given that privileged participants tend to showcase greater access to resources, while the young, the low-income residents, and the disabled remain disproportionately absent [76]. These obstacles illustrate that while co-production exists, it is

necessary to have enduring dedication, structural change, and context-tailored approaches for them to be effectively inclusive.

## 5. Conclusions

Overall, this study demonstrates that the application of the three streams framework, as suggested by Kingdon, effectively explains the phenomenon of smart environmental development, which serves as a fundamental requirement for a Smart City. At the same time, the application of Loeffler's Four Co's Framework provides a comprehensive representation of a full co-production model, highlighting how multi-stakeholder collaboration across co-planning, co-design, co-delivery, and co-assessment contributes to the successful collaboration of smart environment development.

This study also highlights that co-production is an alternative governance model and a fundamental mechanism for sustainable and inclusive public services. Integrating co-commissioning, co-design, co-delivery, and co-assessment aligns with New Public Governance (NPG) principles, reinforcing the importance of participatory decision-making, collaborative policy formulation, and shared accountability. Future research should explore how co-production can be applied to other policy areas in Thailand, particularly in healthcare, education, and social welfare, where citizen participation can enhance policy responsiveness. Investigating power dynamics and decision-making structures within co-production processes can provide insights into ensuring equitable stakeholder representation. Developing a standardized framework for evaluating citizen engagement within the co-production would also be valuable for assessing policy effectiveness and governance transparency.

Although this study offers significant insights, it is important to recognize its limitations. A key limitation of this study is the lack of many direct citizen interviews, as co-production remains a relatively new governance concept in Chachoengsao. Public participation in this study was largely represented by civil society organizations and community leaders rather than individual citizens, who were hesitant to engage in the study. Future research should broaden data collection, incorporating grassroots perspectives and voices, such as participatory workshops and focus groups, to better understand barriers to citizen participation. Longitudinal studies could further track how co-production evolves, offering more profound insights into its institutionalization and long-term impact on public administration. Addressing these gaps will help integrate co-production more effectively into Thailand's governance framework, ensuring that Smart City initiatives remain sustainable, inclusive, and citizen-centric as planned.

## Declaration of competing interest

The authors declare that they have no known financial or non-financial competing interests in any material discussed in this paper.

## Funding information

No funding was received from any financial organization to conduct this research.

## Acknowledgements

The authors thank all key informants for contributing valuable details to cover our research objectives.

## Author contribution

Nattagorn Watto has contributed to the study conception, interview, data analysis and interpretation of results, draft preparation, and final manuscript; Nopraenue Sajjarax Dhirathiti has contributed as the supervisor, providing ideas and improving the manuscript. All authors approved the final version of the manuscript.

## Ethical approval statement

Research ethics approval was obtained. The Ethical approval to report this case was obtained from \* *Committee for Research Ethics (Social Sciences) at the Faculty of Social Sciences and Humanities of Mahidol University, Thailand (MUSSIRB No. 2024/034) \**.

## Informed consent

Informed consent for the publication of personal data in this article was not obtained because the manuscript does not contain images that could identify a person, and other information is anonymized.

## Declaration of use of AI in the writing process

The authors used Grammarly to correct spelling and grammar while preparing this work. The authors reviewed and edited the work as necessary and took full responsibility for the final version.

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