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Traffy Fondue: a smart city citizen engagement

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As urban areas seek innovative solutions to enhance quality of life, integrating citizen participation in smart city projects has become increasingly important. Traditionally viewed as top-down initiatives, these projects can substantially benefit from incorporating citizen feedback and active involvement in addressing urban challenges effectively. This research addresses how citizen participation can enhance the success of smart city projects. Specifically, it explores the case of Traffy Fondue in Bangkok, a digital platform designed to facilitate citizen engagement in officially reporting and resolving urban issues. The study employed a mixed-methods approach, including analyzing data collected from the Traffy Fondue platform and semi-structured stakeholder interviews. The interviews provided insights into stakeholders' perceptions of success factors, while the data analysis focused on identifying common urban challenges and the platform's effectiveness in addressing them. The results indicate that citizen participation, facilitated through the Traffy Fondue platform, significantly contributes to the success of smart city projects. The platform enabled comprehensive data collection on urban issues, allowing for effective problem-solving and enhanced city operations. Stakeholders highlighted the importance of feedback mechanisms and the role of citizen engagement in achieving successful outcomes. Traffy Fondue demonstrated an 84% citizen satisfaction rate while generating annual cost savings of US\$2.14 million for the public sector. The study highlights that incorporating citizen feedback improves the resolution of urban challenges while fostering community engagement and trust in city governance.

KEYWORDS

chatbots, citizen participation, citizen reporting, data-driven participation, SDG 11, smart cities, Traffy Fondue platform, urban innovation

1 Introduction

The growing number of smart cities planned globally introduces an increasing demand for innovation (Zheng et al., 2019). Government and local authorities set budgets to implement their smart city strategies, usually aligned with the country's overall environmental and economic vision and often planned and based on the cities' needs to thrive in economic growth while providing citizens with an improved quality of life (United Nations, 2019, 2023). According to Giffinger et al. (2007), the success of a smart city project can be measured with factors from the following six categories: smart people, smart economy, smart mobility, smart environment, smart living, and smart governance.

One of the primary goals of smart cities is to identify various urban problems and develop strategies to address them. In addition to examining project approaches, the outcome and value proposition of a project must also be evaluated. The success of smart city projects is crucial when there is a clear understanding of how to replicate and scale a

successful initiative. Roengtam (2020) emphasized the importance of three factors in city management thinking: (i) “Adoption of new methods,” which refers to utilizing analytical thinking and citizen feedback; (ii) “adjustment of practice,” which involves building collaboration between agencies and communities; and (iii) “Adjustment of thinking by city stakeholders” to introduce transparency while engaging citizens through public-private partnership (PPP) initiatives and plans (Roengtam, 2020).

Designing and developing a smart city project with citizen participation brings the extra value of enhancing social inclusion and improving the urban quality of life. It is essential to understand that the city depends on its citizens as much as they rely on the city. Improving the city’s infrastructure, environment, housing, healthcare, water supply, solid waste management, wastewater management, education, and employment generation results in a growing economy and improved wellbeing for the citizens. In Hamilton, Canada, citizen participation enabled a valuable feedback process to consistently deliver better value to the citizens (Bradshaw and Kitchin, 2022). Another study found that the challenges of involving citizens with lower digital experiences resulted in a suggestion to combine online participation with conventional (onsite) participation to enable broader citizen feedback (Jang and Gim, 2022).

Urban policies and projects can significantly impact a city’s economy, social welfare, and environment. Recognizing the importance of citizen participation is crucial for the success of smart city initiatives. Despite their global rise, literature often overlooks the role of citizen participation in such projects (Przebylowski et al., 2022). This study addresses this gap by examining how citizen involvement influences smart city innovation in Bangkok, Thailand. The research is significant as it highlights how citizen engagement contributes to the dynamics of urban innovation and identifies factors that facilitate or hinder effective participation in smart city initiatives.

Bangkok, Thailand’s capital city, has been making efforts to improve the quality of life for its citizens through various smart city initiatives and projects. However, Bangkok faces significant challenges, including aging infrastructure, severe traffic congestion, frequent flooding, and waste management issues. These urban problems are often overwhelming due to the rapid population growth and urbanization.

A smart city project in Bangkok is chosen as a primary case study for its innovative citizen participation, addressing urban issues. The Bangkok Metropolitan Administration (BMA) uses the Traffy Fondue platform to gather real-time insights on citizens’ daily struggles, including infrastructure damage, traffic problems, flood incidents, and waste. This customer support-like chatbot helps residents, even those with limited tech skills, easily report urban issues. Daily, citizens highlight ongoing problems such as traffic congestion, damaged roads, overflowing waste, and floods. These reports give city administrators the data needed to take targeted, organized actions to resolve these issues.

The Traffy Fondue (NecTec, 2022; Pornwasin, 2022) chatbot platform was launched by the Bangkok Metropolitan Administration (BMA) on May 31, 2022 (Thai PBS World, 2022, 2024). Therefore, this research analyses the importance and the process of citizen participation in a smart city project and

how success factors, including addressing daily citizen-reported challenges, have helped improve the quality of life for the residents of the Bangkok mega-city.

The remainder of this paper is divided into four sections. Section 2 discusses the conceptual framework and literature. Section 3 presents the case study area of Bangkok. Section 4, Material and Methods, provides an overview of the data collection, analysis methods, and collected data. Section 5, Results and Discussion, presents and discusses the research findings. Finally, Section 6 consolidates and concludes the key findings of this research.

2 Conceptual framework and literature review

This section presents a conceptual framework followed by a literature review, including subsections on smart city innovation, citizen participation, and smart city success criteria. The subsections are organized to follow the research questions (see Section 4.1), facilitating an understanding of how citizen participation impacts the city.

2.1 Conceptual framework

This framework in Figure 1 builds on the Participatory Governance Theory (Arnstein, 1969), which argues that greater citizen involvement leads to increased trust and legitimacy in governance. Additionally, the co-creation model (Voorberg et al., 2015) suggests that when citizens contribute to urban innovation, the effectiveness of smart city initiatives improves. These theories help explain why digital governance platforms like Traffy Fondue enhance service delivery through active citizen input. The conceptual framework begins with the “current city” and progresses to the “smart city” via “smart city innovation,” which is supported by citizen participation and evaluated using the characteristics outlined in the smart city success criteria (as presented in Table 1).

The feedback loop in this framework extends beyond conventional citizen reporting systems by incorporating design thinking methodologies (Roth et al., 2020) and participatory urban planning principles. It refines a model inspired by the American Customer Satisfaction Index (ACSI) (Xu and Zhu, 2021), adapting it to assess the quality of citizen-government interactions in smart city service delivery. Rather than merely evaluating service outcomes, this model emphasizes citizen-driven innovation cycles, where urban authorities actively respond and iterate solutions based on community input. Within the Traffy Fondue platform, the feedback loop operates through the following dimensions: (i) Participatory Digital Governance: Citizens report urban issues and contribute to service design, policy refinement, and infrastructure planning. (ii) Perceived quality: citizens’ perception of the effectiveness and efficiency of Traffy Fondue in addressing their complaints. (iii) Perceived value: the evaluation of Traffy Fondue’s benefits in resolving urban issues relative to the effort required to report complaints. (iv) Satisfaction:

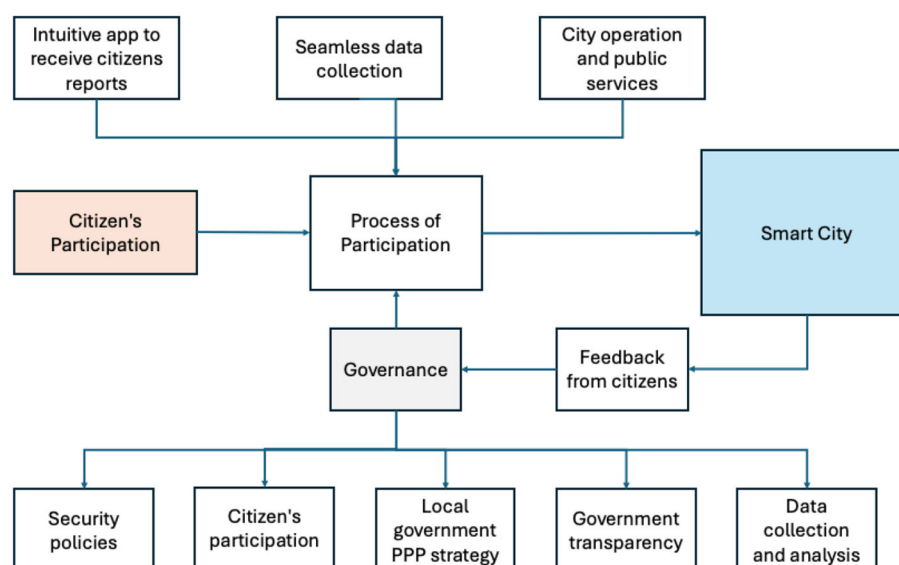


FIGURE 1

Conceptual framework for citizen participation. Source: Authors.

the level of fulfillment experienced by citizens based on the resolution process and feedback mechanisms.

Citizen engagement in smart cities follows a multi-stage process: (i) awareness and accessibility of digital governance tools, (ii) active participation in reporting and feedback mechanisms, (iii) iterative co-creation where citizens contribute to solution design, and (iv) influencing decision-making through direct civic engagement in urban governance.

Beyond issue reporting, smart cities integrate co-creation strategies, such as participatory urban planning workshops, open innovation platforms, and crowdsourced urban data collection. These approaches ensure that citizen input evolves from reactive complaints to proactive city co-development.

Smart city frameworks must address digital literacy gaps through multi-channel participation to ensure equitable engagement. Strategies include hybrid reporting systems (e.g., messaging-based services and offline community centers), multilingual accessibility, and inclusive design tailored to the diverse needs of citizens.

2.1.1 Inclusivity in citizen engagement

While digital governance tools enhance urban responsiveness, the digital divide remains a significant barrier to inclusive citizen engagement. Low-income communities, older populations, and individuals with limited digital literacy often struggle to access and utilize these platforms. Smart city initiatives risk excluding marginalized voices without equitable access, resulting in governance systems that do not address the entire population's needs.

To ensure inclusivity, smart city frameworks must implement multi-channel engagement strategies that combine online and offline participation. For example, community service centers, SMS-based reporting, and paper submissions provide alternative

methods for citizens without smartphone or internet access. Public Wi-Fi zones, smart kiosks, and digital literacy programs can help bridge the digital divide and empower all citizens to engage in urban innovation.

Government partnerships with NGOs and private organizations can promote affordable digital access programs, such as subsidized internet, free smart city application training, and community-led digital literacy workshops. These initiatives ensure that smart city governance remains fair and accessible to all socioeconomic groups.

2.2 Smart city innovation and citizen participation

Smart city innovation applies digital technologies to address urban challenges more efficiently than traditional methods. It leverages digital tools for faster, cost-effective solutions and actively involves the community (José and Rodrigues, 2024).

Digital platforms and data analytics are used to improve urban services management. For example, digital complaint systems simplify reporting issues through mobile apps or online platforms, speeding up resolution and cutting administrative costs.

Efficiency drives smart city innovation. Digital systems improve communication between citizens and officials, enabling real-time responses to urban issues like infrastructure repairs and public safety. Integrating technologies such as the Internet of Things (IoT) allows cities to manage resources effectively and enhance service delivery (Mohanty et al., 2016). However, smart city initiatives may fail if the focus shifts from serving citizens to prioritizing technology over them.

Smart city systems feature interconnected digital technologies that enhance urban living. They include data collection and analytics using sensors and IoT devices to monitor traffic flow and

TABLE 1 Smart city success factors from literature.

Categories	Success factors/criteria	Studies
Smart economy	City ranking compared to other cities	Correia et al., 2021
	Industry and innovation	Iamtrakul and Klaylee, 2019, p. 3–5
Smart environment	Development of sustainable policies	Jayasena and Mallawaarachchi, 2019
	Environment	Crumpton et al., 2021
	Sustainability	Fernando, 2021
Smart governance	Effective political strategies	Jayasena and Mallawaarachchi, 2019
	Government transparency	Iamtrakul and Klaylee, 2019, p. 3–5
	Holistic smart city development	Fernando, 2021
	Open data and datasets	Fernando, 2021
	PPP programmes	Fernando, 2021
	Public policy	Correia et al., 2021
Smart living	Citizens' quality of life effective political strategies	Crumpton et al. (2021); Jayasena and Mallawaarachchi, 2019
	Citizen's participatory development	Correia et al., 2021
	Health and wellbeing	Correia et al., 2021; Crumpton et al., 2021
Smart mobility	Built mobility infrastructure	Crumpton et al., 2021
	Mobility	Aldegheishe, 2019
Smart people	Citizens-first mindset	Fernando, 2021; Correia et al., 2021
	Civic and social	Crumpton et al., 2021
	Focus on solving local issues	Correia et al., 2021
	Improving citizens' quality of life	Correia et al., 2021

Source: Compiled by authors.

energy use, offering actionable insights. Communication networks enable real-time data exchange, enhancing smart city services. Automation technologies like smart grids and waste management optimize resource use and costs for greater efficiency. Citizen engagement platforms allow residents to interact with city services, report issues, and participate in decision-making, promoting inclusivity. Smart infrastructure, like intelligent transportation systems and adaptive traffic signals, supports a sustainable urban ecosystem. Strong security measures protect against data breaches and cyber threats.

Smart city systems support sustainable urban development (Vinod Kumar and Dahiya, 2017). Effective water, energy, and waste management reduces environmental impact and promotes

sustainability. Quality of life improves through efficient services, reduced congestion, better air quality, and enhanced safety. Economic growth results from attracting investments, creating jobs, and fostering innovation. Monitoring environmental factors mitigates climate change and fosters greener spaces. Digital platforms ensure social inclusion, giving all community members, especially marginalized groups, a voice in development, leading to equitable outcomes. Furthermore, smart city systems boost resilience, enabling cities to respond to emergencies, adapt to changes, and recover from disruptions (Angelidou et al., 2017).

Citizen participation plays a pivotal role in the success of smart city initiatives, fostering innovation and ensuring that urban developments align with the genuine needs of the population. Giffinger et al. (2007) emphasize the importance of “smart people” as a fundamental pillar of smart cities, highlighting that citizen intelligence and engagement are critical for shaping and sustaining urban innovation. The active involvement of residents contributes to more inclusive and practical solutions, surpassing the limitations of top-down decision-making by leveraging collective intelligence and diverse perspectives.

Smart city projects use technology and data-driven methods to improve residents' quality of life, with citizen participation being crucial to this effort. Involving citizens allows for co-creating urban solutions that reflect real experiences, promoting a more responsive and adaptable urban environment. Digital tools, like participatory platforms and crowdsourcing applications, enable information exchange, empowering citizens to submit reports and influence decision-making. However, these methods come with challenges. Jang and Gim (2022) emphasize the digital divide as a significant barrier, where individuals with limited digital access may be excluded from participation, resulting in unequal representation in smart city governance.

Empirical research supports the positive impact of citizen participation on urban satisfaction. Xu and Zhu (2021) found that participation enhances satisfaction both directly and indirectly through perceived quality and value in smart cities. However, the current literature predominantly focuses on technological and infrastructural dimensions, often overlooking citizens' subjective experiences. Additionally, the findings of Xu and Zhu (2021) are context-specific, as their study relies solely on data from Qingdao, China, which limits generalizability. Further research across diverse urban contexts is necessary to validate these conclusions and better understand the role of citizen engagement in shaping smart city experiences.

Citizen participation in smart city projects can take various forms, including co-creation, digital engagement, and the utilization of citizen-generated data (Cardullo and Kitchin, 2019). A systems thinking approach (Forrester, 1989) offers a valuable framework for tackling urban challenges by dissecting them into manageable components (Whitehead et al., 2015). This aligns with the principles of smart city governance, where citizen feedback acts as a vital mechanism for problem-solving and urban innovation. Ultimately, nurturing an inclusive participatory ecosystem ensures that smart city initiatives remain people-centric, responsive, and sustainable.

2.2.1 Cases where citizen participation works

Numerous real-world examples indicate that citizen participation in smart city projects has greatly enhanced urban living. These instances illustrate how engaging residents in the development and execution of smart city solutions fosters innovation and improves the overall effectiveness of these projects.

Barcelona, Spain, is a prime example of successful smart city development through strong citizen engagement. The city implemented a digital platform called “Decidim” (which means “We Decide” in Catalan), allowing residents to participate in decision-making processes, propose ideas, and vote on municipal projects. This platform has led to numerous community-driven projects that address local needs and improve public services. The active involvement of citizens has fostered a sense of ownership and accountability, contributing to the city’s sustainable growth and innovation (Smith and Martín, 2021).

Another successful case is Amsterdam, Netherlands. Amsterdam’s “Smart City” initiative fosters collaboration among residents, businesses, and the government. The city has implemented various projects, including smart traffic management systems and sustainable energy initiatives, with significant community input. For example, the Amsterdam Smart Citizens Lab engages residents in gathering and analyzing environmental data, which is then utilized to develop solutions for air quality and noise pollution. This collaborative approach has improved the city’s environmental sustainability and empowered citizens to actively contribute to their urban environment (Mills et al., 2021).

The city of Helsinki, Finland, also illustrates the advantages of citizen participation in smart city projects. Helsinki has implemented the “Helsinki Regional Transport” system, which incorporates real-time data from citizens to optimize public transportation routes and schedules. This system not only enhances the efficiency of public transport but also improves the user experience by addressing commuters’ actual needs and preferences (Dooley, 2021; Kaluarachchi, 2022). Although Helsinki promotes a bottom-up approach, coordination among projects remains challenging, resulting in inefficiencies in achieving broader smart city objectives. Sharing information between cities continues to be difficult as cities have different readiness levels (Shamsuzzoha et al., 2021).

Other success stories can be learned from India’s Smart City Mission, which demonstrates how innovative financial strategies can significantly enhance citizen inclusion in urban projects. By leveraging public-private partnerships (PPPs) and municipal bonds, cities can overcome capital expenditure challenges and ensure that essential infrastructure projects are well-funded. This approach not only addresses financial constraints but also fosters greater citizen engagement, as urban development becomes more closely aligned with community needs, ultimately driving sustainable urban transformation (World Economic Forum, 2023).

2.2.2 Failed cases due to ignorance of citizen participation (especially based on published material)

The absence of citizen participation in smart city projects can lead to significant challenges and, in some instances, outright

failure. Ignoring residents’ input and involvement often results in solutions misaligned with the community’s needs, leading to poor adoption and ineffective outcomes.

One notable example is the Songdo International Business District in South Korea. Songdo was envisioned as a cutting-edge smart city with advanced technologies and sustainable infrastructure. However, its development has faced criticism for being overly focused on a top-down management structure, with insufficient engagement from residents and businesses (Rugkhan and Murray, 2019). According to a study by Hollands (2015), the lack of citizen participation during the planning and implementation phases resulted in a city that felt artificial and disconnected from its inhabitants. Consequently, many of the smart systems implemented did not address the daily needs of the residents, leading to underutilization and dissatisfaction (Hollands, 2015).

Another example is the Masdar City project in Abu Dhabi. Masdar City aimed to be a zero-carbon, zero-waste urban development powered entirely by renewable energy. Despite its ambitious goals, the project faced significant challenges due to limited citizen involvement (Hollands, 2015).

The Sidewalk Labs project in Toronto’s Quayside area exemplifies how neglecting genuine citizen participation can undermine ambitious smart city initiatives. Initially presented as a cutting-edge urban development, the project encountered considerable controversy and ultimately failed. A central issue was the lack of clarity regarding data privacy and governance. Sidewalk Labs proposed collecting extensive data through sensors, cameras, and Wi-Fi networks to optimize urban operations. However, the absence of a robust and independent data governance framework sparked fears of surveillance and commercial exploitation. The proposed “data trust,” aimed at overseeing data management, faced criticism for being vague and legally inadequate (Goodman and Powles, 2019; Chantry, 2022). Citizens and advocacy groups were divided on whether this framework could effectively protect their rights.

Transparency in decision-making emerged as a critical failure. Agreements between Sidewalk Labs and Waterfront Toronto faced criticism for their opacity, particularly regarding data ownership and monetisation. Public engagement efforts, such as consultation sessions, were perceived as superficial. Citizens could propose minor design changes, like parks, but were excluded from major discussions on privacy policies and the project’s scope. The Residents Reference Panel, intended to represent public input, lacked the authority to influence significant project decisions, which undermined trust in these efforts.

Corporate overreach sparked public backlash. Initially limited to 12 acres, Sidewalk Labs sought to expand to 190 acres, proposing a light-rail system. This was perceived as a corporate land grab prioritizing private interests over public welfare, straying from the project’s original goals. Advocacy group “BlockSidewalk” mobilized opposition, accusing Sidewalk Labs of prioritizing profit over public interests. Resistance grew with high-profile resignations, including Ann Cavoukian, Ontario’s former privacy commissioner, who left her advisory role, citing a lack of commitment to “privacy by design.”

Governance misalignment between Sidewalk Labs and Waterfront Toronto greatly impacted the project's failure. Waterfront Toronto prioritized public interest, often clashing with Sidewalk Labs' corporate goals. This tension highlighted governance weaknesses in balancing private innovation with public accountability, exposing risks of private firms leading urban initiatives without sufficient oversight (Chantry, 2022).

In May 2020, Sidewalk Labs canceled the project, citing "unprecedented economic uncertainty" from the COVID-19 pandemic. However, unresolved governance, data privacy issues, and public opposition were key reasons for its failure (Goodman and Powles, 2019; Chantry, 2022). As Chantry (2022) notes, the Quayside project highlights the dangers of tokenistic engagement and opaque decision-making in smart city planning. Without strong citizen participation, transparent governance, and enforceable privacy measures, even innovative urban projects may alienate the communities they intend to serve.

2.2.3 People-centric methods adopted from business innovation

Prior work has highlighted how business innovation and design principles can enhance citizen participation and engagement in urban development (Albino et al., 2015). Rather than viewing citizens solely rather than passive consumers of municipal services (Becker et al., 2023; Malek et al., 2021). Empowering citizens as partners with local government and private sectors can foster entrepreneurial approaches to urban problem-solving (Becker et al., 2023). Integrating citizen perspectives into smart city initiatives builds strong engagement with local government (Becker et al., 2023; Malek et al., 2021; Lyu et al., 2022; Voelz et al., 2023; Zamani et al., 2023). Other smart city frameworks stress integrated service delivery and urban infrastructure (Anthopoulos et al., 2018). These models argue that smart cities should create user-focused systems that meet diverse citizen needs (Sharifi, 2022; Lee et al., 2020; Secinaro et al., 2021).

Citizens are vital to the city ecosystem; they shape the city (Voelz et al., 2023). A sense of belonging to a community and participation in local government decisions enhance citizens' satisfaction levels. This is supported by implementing a citizen-centric strategy, where public services are tailored to meet citizens' daily needs and activities (Bruegge, 2021).

Like business operations, cities must keep citizens happy, aligning with a citizen-centric approach (Becker et al., 2023; Lyu et al., 2022). Citizen participation is complex; communities must be identified to grasp their challenges and needs (Adelina et al., 2021). Innovation processes like design thinking address these issues (Nielsen et al., 2019). Decisions often favor citizens, reinforcing the citizen-centric approach (Mata et al., 2021). Engaging diverse citizens poses a challenge, as many cannot access technology-based smart city solutions, contributing to the digital divide affecting seniors and others unable to afford devices. Although narrowing, this gap remains a concern (Kaur et al., 2021; Lim and Zainal, 2022).

In the context of smart cities, the current approach to citizen participation involves developing community activities and engaging with local government representatives or stakeholders (Bastos et al., 2022; Das, 2024; Kaszkur and Kapsa, 2019). In

Bangkok, this citizen participation is exemplified by a chatbot called Traffy Fondue, which allows citizens to submit complaints and provides valid proof of participation initiated and facilitated by the city government (BMA), as complaints have been addressed (NecTec, 2022; Pornwasin, 2022; Sangkeetrakarn, 2022).

2.3 Smart city system and criteria for success

Experts identify key criteria for smart city projects, including public service efficiency, citizen skills, economic development, and participation. Giffinger et al. (2007) define six smart city categories: smart people, economy, mobility, environment, living, and governance. Xu et al. (2021) affirm these categories and outline five success factors: (i) expertise and technology availability, (ii) funding availability, (iii) data availability and management effectiveness, (iv) infrastructure support, and (v) environmental sustainability and governance. These categories serve as a strong segmentation framework, as shown in Table 1, classifying success criteria accordingly.

The study of the Traffy Fondue platform's success criteria closely aligns with the factors identified in smart city studies (as shown in Table 1). Government transparency is emphasized through the use of open data and datasets, as noted by Iamtrakul and Klaylee (2019), Fernando (2021), Aldegheishem (2019), and Vinod Kumar and Dahiya (2017). This transparency builds trust by enabling citizens to access and review public information. Additionally, the Traffy Fondue platform integrates advanced technology and effective data management systems, enhancing operational efficiency and credibility.

Civic and social factors, such as a citizens-first mindset and human capacity building, are crucial for the initiative. Studies by Aldegheishem (2019), Crumpton et al. (2021), Correia et al. (2021), Fernando (2021), and Jayasena and Mallawaarachchi (2019) emphasize the importance of valuing citizen opinions and encouraging active participation, which Traffy Fondue achieves through inclusive engagement strategies.

Public-private partnerships (PPP) are another important criterion. Iamtrakul and Klaylee (2019), Fernando (2021), and Jayasena and Mallawaarachchi (2019) highlight the significance of PPP programs and effective stakeholder management. Traffy Fondue facilitates collaboration with private sector service providers, leveraging their strengths to drive innovation and enhance service delivery.

Innovation is a central theme, as the Traffy Fondue platform promoting environments that promote industry and innovation. This idea is supported by Iamtrakul and Klaylee (2019) and Aldegheishem (2019), who discuss the significance of fostering innovation through experimentation and the development of new solutions.

The Traffy Fondue platform also focuses on personal privacy policies, aligns with government initiatives, and implements effective political strategies. Studies by Iamtrakul and Klaylee (2019), Crumpton et al. (2021), Fernando (2021), Correia et al. (2021), and Vinod Kumar and Dahiya (2017) emphasize the necessity for public policy and strategic governance, which Traffy Fondue integrates into its framework.

Health, wellbeing, and environmental initiatives are essential for improving citizens' quality of life. Crumpton et al. (2021) and Correia et al. (2021) emphasize these aspects, which Traffy Fondue supports by raising awareness of health and environmental issues. These initiatives contribute to a more livable city.

Fernando (2021) and Correia et al. (2021) highlight the need for holistic smart city development with a long-term vision. The Traffy Fondue platform supports this by focusing on sustainability, effective communication, continuous improvement, and stakeholder engagement.

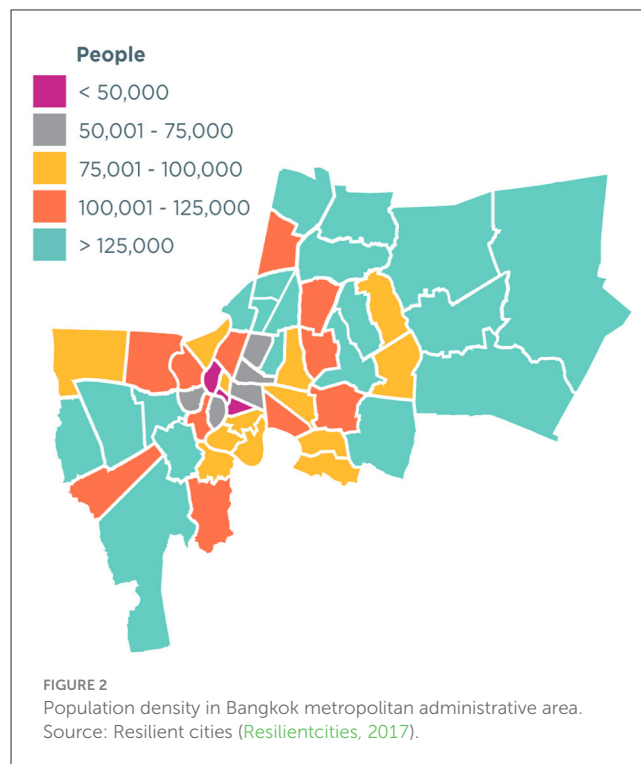
The development and execution of a smart city necessitate collaboration among the government, the private sector, and citizens. To effectively serve the population, city public service systems must adapt to the smart city's transformation. Singapore initiated its smart city adventure by integrating automation and ICT within the government sector, aiming to enhance efficiency and elevate the skill levels of public staff to foster a more innovative mindset (Hartley et al., 2018). Regarding the concept of a 'smart government', Guenduez et al. (2018) identify key success factors, which are (i) organizational capabilities, (ii) environmental prerequisites, (iii) strong leadership, and (iv) the establishment of shared strategies and standards. The authors stress the importance of a citizen-focused approach where innovation and entrepreneurship energize citizen involvement and public-private partnerships (Guenduez et al., 2018). In addition, the leadership's function is pivotal in promoting sustainable innovation, which is vital for achieving resilience, equality, and transparency in strategies (Daniel et al., 2020).

Aligned with the categories outlined by Giffinger et al. (2007) and Aldegheishem (2019, p. 57–58) identified 12 success factors for a smart city: living, economy, environment, education, governance, energy, safety, mobility, technology, buildings, hospitals, and people. Within these categories, Aldegheishem (2019) argued that the five most important factors are People, Technology, Governance, Environment, and Mobility. Here, "people" represents citizens' participation and mobility; "technology" and "governance" focus on enhancing various processes in the public sector while introducing efficiency and improving the quality of life for citizens. "Environment" pertains to enhancing the urban landscape through efficient waste management, air quality, and green spaces. Lastly, "mobility" refers to public transportation, infrastructure, and innovative transportation systems.

3 Case study area: Bangkok

Thailand has long advocated for citizen participation. The trust relationship between citizens and the public sector is generally established through social networks, many of which are linked to the public sector (Suebvises, 2018). The public sector leadership understands that gaining the citizens' voices could improve their credentials and future support.

Although Thailand's smart city initiative has its roots in 2003, it was formally launched in 2016, when the country actively began its smart city journey in connection with the "National 4.0 Policy" (Irvine et al., 2022). The policy promotes digital technology and was set in motion to elevate Thailand's industry through digital transformation. The smart city initiatives in Thailand are managed



by the Digital Economy Promotion Agency (DEPA), under which the ministry defines a smart city as:

A city that uses modern technology and innovation to increase the efficiency of city services and management, reducing the cost and resource usage of both the city and its citizens. It focuses on good design and the participation of businesses and public sectors in urban development, aiming for a modern and livable city where people enjoy a good quality of life and sustainable happiness. (Irvine et al., 2022, p. 3).

On the Digital Economy Promotion Agency (DEPA) website (Depa, 2022, 2024), cities are given guidelines for developing a smart city strategy. Projects can be categorised into the following seven areas: (i) smart environment, (ii) mobility, (iii) living, (iv) people, (v) energy, (vi) economy, and (vii) governance. According to Depa (2024), these categories represent the "success factors for a smart city."

Bangkok, Thailand's capital, is a key economic hub with significant influence in Southeast Asia. Its strategic location draws a diverse workforce, enhancing its multicultural vibrancy. The population grew from 1.6 million in 1958 to about 11.23 million in 2024, which poses urban challenges and reinforces its status as a socio-cultural and economic centre known for tourism, street food, shopping, and a blend of architecture. This growth highlights the need for effective governance to ensure equitable economic opportunities. High population density and increased vehicles worsen traffic congestion, a primary issue in Bangkok, despite gradual public transport development like the "Skytrain" and metro systems since 1999. Figure 2 shows the population density in Bangkok's mega-city districts, which is useful for analysing data in urban infrastructure planning and management.

TABLE 2 Compares citizens' reporting platforms.

Feature	Traffy Fondue (Thailand)	FixMyStreet (UK)	SeeClickFix (USA)	OneService (Singapore)
Primary function	AI-driven complaint reporting and resolution tracking	Local issue reporting to councils	Community-based issue reporting and tracking	Multi-agency complaint submission for municipal issues
Technology Integration	Uses AI and machine learning for issue categorisation and automated responses	Web and mobile-based reports; no AI-driven automation	Includes mobile app, web reporting, and crowdsourced issue tracking	Mobile-first with smart routing of issues to the right agency
Government involvement	Integrated directly with Thai municipal agencies and government offices	Issues reported to relevant local authorities	Municipalities can opt-in, but it also works as a community-driven tool	Fully government-operated under Singapore's Smart Nation initiative
Alternative reporting methods	Limited (primarily digital)	Online and offline reporting (some councils accept phone or in-person reports)	Supports phone and offline submission in select municipalities	Call centers and government helpdesks also accept reports
Feedback loop	Citizens receive updates on resolution progress	Limited updates; dependent on council response	Interactive platform where citizens and local officials communicate directly	App provides status tracking and estimated resolution times
Open data API availability	Yes, open API available (for Bangkok)	Yes, open API available	Yes, open API available	No public API for open data access

The case study in this paper focuses on the Traffy Fondue platform (the platform) used in the administrative area of Bangkok mega-city. A background study was conducted to better understand the platform and its value proposition; this was achieved by reviewing material about Traffy Fondue, news articles, and data generated by the platform. This includes the initial design and development and the initial proof of concept from Phuket, which directed the platform toward today's usage scenario. The background information will uncover the strategies and uses of the platform and provide a vision for Traffy Fondue for other applications by understanding the platform's opportunities and data collection strategies.

3.1 Comparing Traffy Fondue with global smart city complaint platforms

Smart city complaint management systems are essential for helping citizens report urban problems effectively. Although platforms such as FixMyStreet¹ (UK) and SeeClickFix² (USA) have gained traction in Western nations, Traffy Fondue³ (Thailand) and OneService⁴ (Singapore) exemplify how Southeast Asian cities are embracing digital governance initiatives.

The Table 2 compares these platforms according to their technology integration, government involvement, accessibility, and data openness via APIs.

While FixMyStreet and SeeClickFix have gained significant traction in Western cities, Traffy Fondue sets itself apart with its AI-driven approach, which automates complaint categorisation

and resolution tracking. However, its digital-only nature poses challenges for users without smartphones or internet access.

3.1.1 Unique features of Traffy Fondue

Traffy Fondue significantly enhances smart city governance through the following features: (i) AI-Driven Categorisation: unlike FixMyStreet and SeeClickFix, which depend on manual classification, Traffy Fondue utilises AI algorithms to automatically categorise, prioritise, and assign complaints to the appropriate authorities (Tortermvasana, 2024). (ii) Government Integration: unlike SeeClickFix, which requires municipalities to opt in, Traffy Fondue is integrated into Thailand's smart city framework, facilitating direct municipal engagement in resolving issues. (iii) Automated Feedback System: unlike FixMyStreet, which provides minimal follow-up, Traffy Fondue keeps citizens informed about the status of their complaints through automated, AI-generated updates.

3.1.2 Can Traffy Fondue platform be applied to other cities?

Traffy Fondue's AI-driven model provides considerable scalability for cities beyond Thailand, especially in Southeast Asia, where rapid urbanisation has heightened the demand for smart city solutions (Fernandez and Pérez, 2024). However, its digital-first nature presents challenges for lower-income areas with limited internet access.

The following modifications should be considered to adapt Traffy Fondue for other cities: (i) Hybrid Complaint Reporting: implementing SMS-based reporting, call centres, or kiosks to connect with lower smartphone usage areas. (ii) Localisation and Language Adaptation: many Southeast Asian cities are multilingual, so adapting to local languages enhances accessibility. (iii) Scalability in Emerging Economies: unlike the UK and USA, where digital literacy is high, cities with lower digital literacy may require training programs to help residents navigate AI-driven platforms.

1 <https://www.fixmystreet.com/>
2 <https://seeclickfix.com/>
3 <https://fondue.traffy.in.th/bangkok>
4 <https://www.oneservice.gov.sg/>

3.2 Data analysis and prediction modelling Traffy Fondue data

The Traffy Fondue platform collects large-scale urban complaint data submitted by citizens, covering issues such as traffic congestion, road infrastructure damage, waste management, flooding, and public safety concerns. When effectively analysed, this data offers valuable insights that can enhance point-of-interest (POI) recommendation, route optimisation, and predictive urban mobility models.

3.2.1 POI recommendation using complaint data

Point-of-interest (POI) recommendation systems rely on user check-in data, social media interactions, and geolocation patterns. However, incorporating complaint data from Traffy Fondue adds a new layer of contextual information, enhancing personalised recommendations and city planning efforts. Unlike traditional POI recommendation models that primarily depend on business popularity or user reviews, complaint data helps highlight urban areas needing more amenities (Acharya and Mohbey, 2025). The frequency of complaints in specific locations can adjust POI rankings by prioritising places with better infrastructure, cleanliness, and safety conditions. Governments can utilise citizen-reported issues to identify missing facilities, such as bus stops, street lighting, or pedestrian crossings, and incorporate them into future urban developments (Hansen et al., 2025).

3.2.2 Route optimisation for smart mobility

The geospatial distribution of complaints from Traffy Fondue provides real-time indicators of road quality, identifies congestion hotspots, and highlights transportation disruptions, making it a valuable resource for route optimisation algorithms. Traffic prediction models can utilise historical complaint data to redirect vehicles away from congestion-prone areas, minimising delays caused by road damage or traffic bottlenecks (Lin, 2024). Frequent complaints regarding potholes, road degradation, or flooding enable transport agencies to develop a road quality index, enhancing route recommendations for cyclists, pedestrians, and autonomous vehicles (Fernandez and Pérez, 2024). Ride-hailing and logistics services could employ real-time urban issue reports to streamline delivery routes, reducing travel time and improving transport efficiency.

3.2.3 Traffic prediction using citizen complaint data

Traffic forecasting models typically rely on sensor-based data, GPS tracking, and vehicle counts; however, integrating complaint data enhances prediction accuracy by incorporating citizen-reported disruptions. Machine learning models can analyse complaint trends over time to forecast peak congestion areas, factoring in reported accidents, roadworks, and traffic obstructions (Lin, 2024). Reports of urban flooding from Traffy Fondue can be integrated with real-time weather data to model the impact of natural hazards on traffic mobility (Hansen et al., 2025). Combining urban complaint reports with IoT sensor networks and

satellite imagery enables smart cities to optimise predictive traffic management systems (Fernandez and Pérez, 2024).

4 Material and methods

This section outlines the research questions and design of this study. It is divided into two main parts: the Research Question section and the Research Method section. The Research Question section describes the purpose of the study. The Research Method section details the methods used, which include quantitative analysis of data from the Traffy Fondue platform and qualitative analysis from semi-structured interviews.

4.1 Research question

The primary aim of this research study is to investigate the reasons behind the success of smart city projects that actively engage citizens. Understanding the factors that contribute to these projects' success with citizen participation is crucial for developing effective strategies that can be replicated in future initiatives. The study seeks to identify the specific factors that define the value proposition of successful smart city projects, emphasising the role of citizen participation.

Research Question (RQ). Why do smart city projects succeed with citizen participation? What factors define the value proposition of a successful project?

To better understand this question, it was divided into two sub-questions.

Research Sub-Question (RSQ1). What process is used to incorporate citizen participation in successful projects?

Incorporation Process (RSQ1): This sub-question examines the methods and processes of integrating citizen participation into successful smart city projects. It explores the strategies, frameworks, and practices that facilitate effective citizen participation and ensure their active involvement and collaboration throughout the project lifecycle.

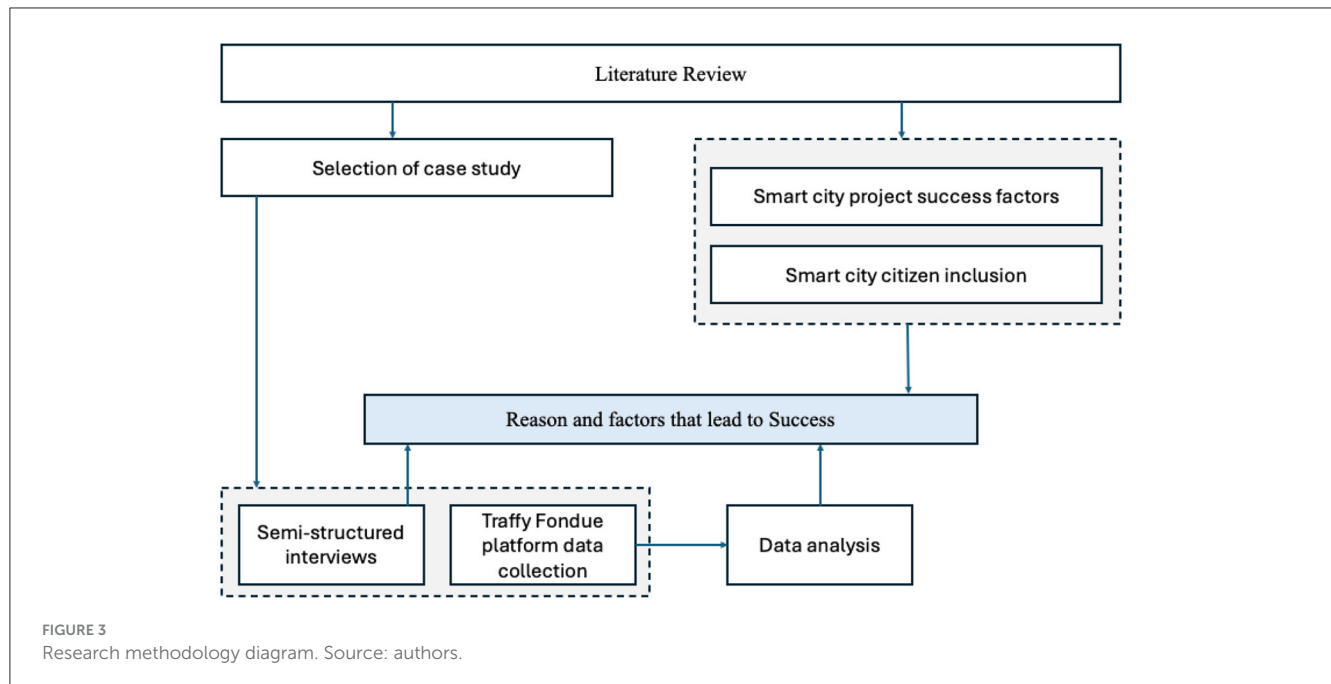
Research Sub-Question (RSQ2). What value do citizens add to smart city projects that succeed?

Value Added by Citizens (RSQ2): This sub-question investigates how citizen participation enhances the effectiveness, sustainability, and overall impact of these projects, emphasising the community's roles, responsibilities, and inputs.

4.2 Research methods

The study encompassed a literature review, case study selection, and background information gathering, with data collection primarily conducted through a mixed methods approach, integrating qualitative and quantitative data collection techniques. Qualitative elements included semi-structured interviews with stakeholders directly or indirectly involved in city or urban innovation initiatives. Simultaneously, city operations gathered quantitative data from a chatbot to collect citizens' complaints.

Figure 3 illustrates the progression from research questions to the dissection of each research element, including the literature review, selection of use cases, semi-structured interviews,



and data collection. The results were analysed to address the research questions.

4.2.1 Qualitative research methods

4.2.1.1 Literature review

A literature review (Section 2) was conducted to establish a foundational understanding of citizen participation in urban settings. This review explored existing knowledge on smart cities and citizen engagement, laying the groundwork for the research. It identified challenges related to citizen involvement in urban projects.

The review included diverse sources, such as academic studies, public reports, and news articles, to identify critical factors pertinent to the research identifying RSQ1, which addresses the processes of incorporating citizen participation, and RSQ2, which explores the value added by citizen participation. The review examined how such involvement contributes to enhanced project outcomes, including improved sustainability, innovation, and community support.

The search terms utilised included phrases such as “*citizen participation*”, “*citizen inclusion*”, “*smart city projects*”, and “*success factors related to these initiatives*”. The analysis focused on frameworks, strategies, and methodologies for effectively integrating citizens into urban projects, highlighting indicators for success factors and key areas for smart city initiatives. The findings are based on case studies or research. For instance, [Fernando \(2021\)](#) discussed “*open, city-wide databases and platforms*” that allow citizens to access city data freely. Another example from [Crompton et al. \(2021\)](#) identifies six development areas: (i) Civic and Social, (ii) Health and Wellbeing, (iii) Security, (iv) Quality Environment, (v) Built Infrastructure, and (vi) Industry and Innovation. The authors emphasise the importance of the government sector in prioritising input from local communities, aligning with the development area of (i) Civic and Social.

4.2.1.2 Semi-structured interviews

This study involved 12 semi-structured interviews with experts, scholars, and practitioners in smart cities from various sectors, including public agencies like Thailand’s DEPA, knowledge institutions such as Thammasat University and the Asian Institute of Technology, and multilateral banks like the Asian Development Bank. A representative from the Bangkok Metropolitan Administration also participated. The interviews helped gather insights about existing processes in Thailand’s smart cities, upcoming strategies, leadership engagement, training, and experiences with the Traffy Fondue platform. Stakeholders shared their perspectives and experiences related to other Southeast Asian cities, adding depth to the study. The goal of these sessions was to capture stakeholders’ perceptions of the value propositions and success factors of smart city projects they were involved in. To facilitate the semi-structured interviews, initial guiding questions were developed.

- Question 1: please describe your city’s most successful smart city project. What key features contributed to its success, and how has it impacted the community?
- Question 2: what was your involvement in the project, if any?
- Question 3: how successful was the project, and what factors contributed to its success?
- Question 4: how did the project incorporate citizen participation, and at which stage do you believe this involvement impacted the project’s outcome the most?
- Question 5: how does the project contribute to making Bangkok a smart city and improving the quality of life for its citizens?

The participants provided their views from each SSI session, and the results were consolidated and analysed to evaluate how they aligned with each other. Following the SSI, data from the Traffy Fondue platform was collected and analysed. This provided



an additional understanding of the innovative approach and design of the chatbot (digital platform), and this data included information about citizens' locations and their concerns regarding problems related to urban infrastructure and services in those locations. From the semi-structured interviews with stakeholders using or involved with Traffy Fondue, the following questions helped develop an understanding of the Traffy Fondue project:

Traffy Fondue platform:

- Q.1 How was the Traffy Fondue platform designed?
- Q.2 What makes the interface design intuitive?
- Q.3 What are the main challenges that the Traffy Fondue platform solves?
- Q.4 How does the Traffy Fondue platform provide feedback to the users about their complaint status?
- Q.5 How does the platform's administration service work, and how are the staff adapting to the process?

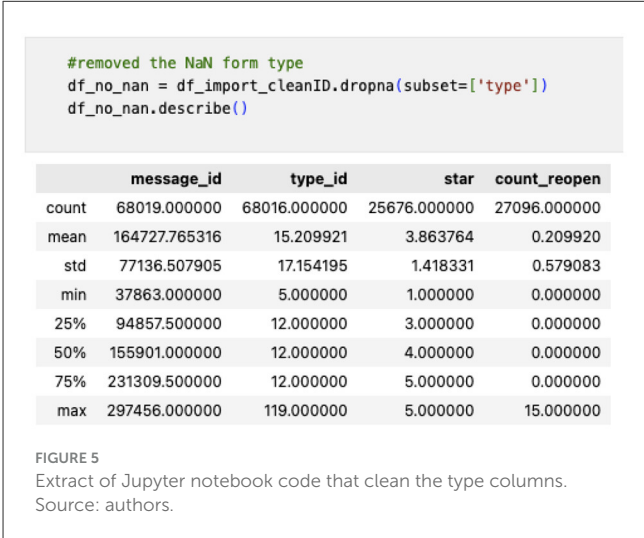
4.2.2 Quantitative data sourcing

The Traffy Fondue is an innovative smart city project in Bangkok. Its open data platform supplies publicly available data (NecTec, 2024), making it possible to extract and analyse historic and live data. This research selected data from a 9-month window.

To obtain the dataset, the official platform accessed the Application Programming Interface (API) provided by Traffy Fondue (NecTec, 2024). The retrieved dataset contained a sample size of 98,000 reports uploaded by citizens covering areas of concern within various neighbourhoods. This dataset facilitated an analysis of the number and frequency of complaints reported over time, offering insights into patterns of urban issues, civic engagement, and municipal responsiveness.

Upon retrieval, the data was organised according to the schema defined by Traffy Fondue. To ensure data quality, it was processed in a Jupyter Notebook using the Pandas library in Python. The dataset was first loaded into a Pandas DataFrame, followed by a cleaning process that removed fields with missing or non-relevant values (NaN). The dataset was then filtered to retain only records where all relevant fields were complete, ensuring analytical accuracy and reliability. Thai language fields were translated into English and added in an extra column to aid in understanding the output data during processing. The following Python code demonstrates this process (Figures 4–7):

The data was explored over time, from May 2022 to December 2022, to understand the volume of complaints per day and month. The data was then analysed by examining the correlation between



the types of complaints and, ultimately, the volume of complaints by geographical location, which was converted into district areas in Bangkok (Figures 8–10).

One area we explored was the different types of complaints. For example from Table 3, a selected number of complaint types was selected to display the number of complaints across the district in Bangkok. These complaint types were selected because of the higher number of complaints, making them significant for the study.

5 Results and discussion

This section is divided into three sub-sections, starting with Sections 5.1 and 5.2, which address the sub-research questions, followed by 5.3, which synthesises the findings related to the main research question.

5.1 Smart city innovation—Citizens incorporation process (RSQ1)

The Government of Thailand has explored various strategic approaches to urban development. According to DEPA, many cities enrolled in the smart city programme understand the smart city strategy and use design thinking tools to establish a more inclusive city, as the Sustainable Development Goal (SDG) 11 emphasises. Such activities can start citizen participation in selected projects

```

# language support
type = {
  'อื่นๆ': 'Other',
  'ถนน': 'Road',
  'ทางเท้า': 'Sidewalk',
  'น้ำท่วม': 'Flood',
  'แสงสว่าง': 'Light',
  'ความปลอดภัย': 'Safety',
  'ความสะอาด': 'Cleanliness',
  'ท่อระบายน้ำ': 'Drain',
  'สะพาน': 'Bridge',
  'กีดขวาง': 'Obstruction',
  'จราจร': 'Traffic',
  'สายไฟ': 'Electric Wires',
  'คลอง': 'Canal',
  'ต้นไม้': 'Tree',
  'เสียงรบกวน': 'Noise',
  'สัตว์จรจัด': 'Stray animals',
  'ป้าย': 'Signage',
  'ร้องเรียน': 'Complaint',
  'เสนอแนะ': 'Suggestion',
  'คนจรจัด': 'Homeless',
  'การเดินทาง': 'Journey',
  'สอบถาม': 'Inquiry',
  'ห้องน้ำ': 'Bathroom',
  'PM2.5': 'PM2.5',
  'ป้ายจราจร': 'Traffic Signs'
}

#state should be the same as status
state = {
  'ส่งเรื่องแล้ว': 'Submitted',
  'กำลังดำเนินการ': 'In progress',
  'เสร็จสิ้น': 'finish',
  'ส่งต่อ(ใหม่)': 'Forward(New)',
  'ของบประมาณ': 'Ask for a budget.',
  'รอรับเรื่อง': 'Waiting to get the story.',
  'ไม่เกี่ยวข้อง': 'Irrelevant.'
}

statelistkey = list(state)
print(statelistkey[0])

```

FIGURE 6
Extract of Jupyter notebook code, translations Thai to English.
Source: authors.

and provide more insight into information about local issues and citizens' needs (Rattanasevee, 2022).

As members of the BMA team explained in the semi-structured interviews, the goal is to build a trustworthy administration that can identify the citizens' needs and actively respond to and resolve the problems to the citizens' satisfaction. In May 2022, when Dr. Chadchart Sittipunt took office as the Governor of Bangkok, he presented his vision of a much more inclusive city. To operationalise this vision, one of the projects launched by BMA was the Traffy Fondue platform, developed by (NecTec, 2024). The Traffy Fondue platform was inspired by the customer service process, which enables customers or citizens to report and submit complaints via an online system.

The backend architecture uses an AI engine to process the complaints and sort them into categories. The categories defined

in the platform are (i) Road, (ii) Sidewalk, (iii) Flood, (iv) Light, (v) Safety, (vi) Cleanliness, (vii) Drain, (viii) Bridge, (ix) Obstruction, (x) Traffic, (xi) Electric wires, (xii) Canal, (xiii) Tree, (xiv) Noise, (xv) Stray animals, (xvi) Signage, (xvii) Suggestion, (xviii) Homeless, (xix) Journey, (xx) Inquiry, (xxi) Bathroom, (xxii) PM2.5, (xxiii) Traffic signs, (xxiv) Others. From there, the workflow engine assigns the complaints to a task assignment, which is then pushed directly to the agency responsible for handling the problem (NecTec, 2022).

When a citizen wants to submit a complaint about urban infrastructure and services (Rattanasevee, 2022), they can do so via mobile phones, from which the Traffy Fondue digital platform organises the complaints to be distributed to the responsible agency. For example, a problem reported with a pothole in the road will be directed to the Traffic and Transportation Department, which may have a repair agreement with a contractor. According to BMA team members, in June 2022, just a month after the new Governor was elected, more than 200 projects were identified for the city to perform repairs or improve infrastructure. Meanwhile, as the Traffy Fondue platform became operational, thousands of citizens started sending complaints using the platform, and its usage as a smart city solution gradually gained momentum with citizen participation.

The Traffy Fondue platform is a chatbot on Line, popular among smartphone users in Thailand. Citizens can report complaints digitally through the app by sending a message. The chat screen provides menu options for flood complaints, surveys, user statistics, and submitting new complaints. Upon selecting 'submit a new complaint,' users can share their location on the map and choose a category: city services, police, electricity, or water. Finally, they provide a photo and description, while the chatbot guides them through the process to ensure useful information is submitted. Users can also view a summary of their submitted complaints and request status updates.

On the back end, the Traffy Fondue platform is designed to collect complaints and use predefined categories to assign the complaints to a responsible organisation in BMA. The staff in each organisation will have access to the Traffy Fondue platform and related databases and can view the list of complaints assigned to them. Sometimes, the complaint will be forwarded to the repair team or contractors. In other cases, the complaint will have to go through a process of evaluation, budgeting, and project execution. Some citizens (as users) describe the process as "intuitive" and believe this inclusive urban service brings growing awareness to the public sector in Bangkok. This means citizens can share information about problems and concerns related to infrastructure and services in the Bangkok mega-city. The data is published on a public website (Teamchadchart, 2024) and advertised by the Governor of Bangkok (Parpart, 2023).

The innovative part of the Traffy Fondue platform is the design and integration with a messaging application. This can be any messaging application, such as WhatsApp, Line, WeChat, or Telegram. However, the most popular messaging app in Thailand is Line, with a penetration rate of 92.8% among the country's internet users (Joyce, 2022). With a population of 70.01 million (Kemp, 2022), Thailand has one of Southeast Asia's highest internet user ratios at 77.8 percent. Since most mobile users utilise Line, the research team behind Traffy Fondue opted to develop the

```

#add a typecode column and a statuscode column and in star and count_reopen change NaN to 0
#add statuscode and typecode column
statuscode = []
for s in df_tcol.loc[:, "state"]:
    if s in state:
        indexvalue = statelistkey.index(s)
        statuscode.append(indexvalue)
    else:
        statuscode.append(-1)

#print(statuscode)
df_tcol["statuscode"] = statuscode

# Add empty column with translated name of type
#print(df_traffycol['type'].value_counts())
for t in type:
    # print("key: ", t, " English: ", type[t])
    # print(df_traffycol['type'].str.contains(t).value_counts())
    #add empty col with new colname
    df_tcol[type[t]] = 0

#add a status code column assign na
df_tcol['statuscode'] = np.nan
df_tcol.columns

```

FIGURE 7
Extract of jupyter notebook code, add translated text column. Source: authors.

Traffy Fondue Line chatbot screenshot



The text in this screenshot has been translated from Thai to English

FIGURE 8
Screenshot from Traffy Fondue Line chatbot with translated text. Source: authors.

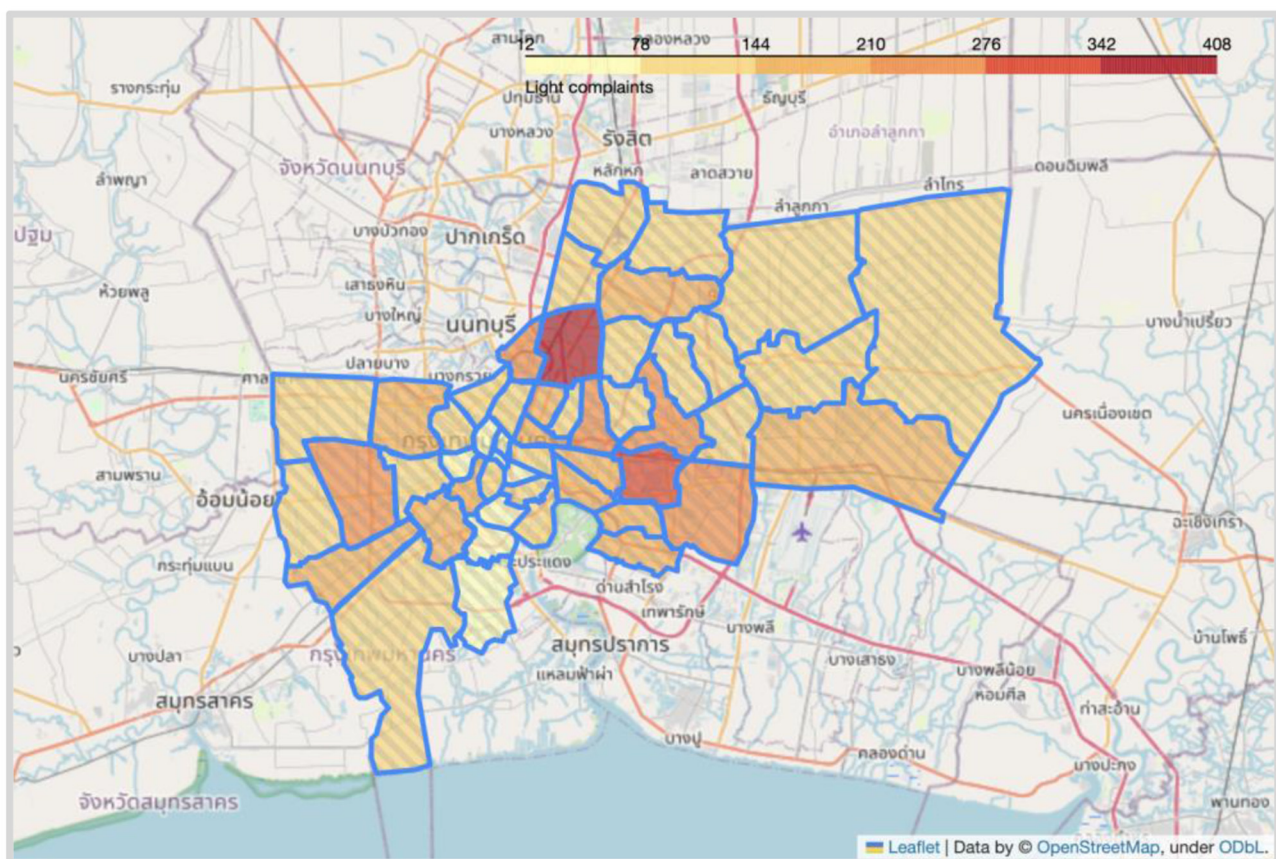


FIGURE 9

Geographical distribution of citizens' reports on problems related to street lights. Source: authors.

solution as a chatbot. This innovative approach reduced the need for a new user interface and reduced the learning curve of using a new application.

Traffy Fondue collects and processes personal data to support urban governance and improve services. As outlined in its Privacy Policy (Traffy: Privacy Policy, 2022), the platform gathers personally identifiable information (PII) such as email addresses, phone numbers, device information, and usage data. This data enhances service responsiveness, monitors urban issues, and facilitates communication with users. However, as with any digital governance tool, data privacy, security, and user rights are critical considerations that must be addressed.

The chatbot guides users by instructing them on what to write or take a picture of to post. It then describes the issue they wish to complain about and provides a brief description and location. The Line platform automatically captures the GPS location of the complaint and categorises it according to one of the fourteen categories currently supported in Table 4. Suppose the complaint falls into an unknown category. In that case, the report is processed manually by placing it in the correct category or by raising a support ticket to create a new category.

The average resolution time has decreased from months to about 2 days (Wancharoen, 2024). When resolved, citizens evaluate the outcomes of complaints or resolutions, recognising the city administration's effective responses and solutions.

This information can assist the city administration in better understanding its responsiveness to citizens' complaints and outline a pathway for improvement in developing a smarter city.

From Research Sub-question 1. "What process was used to incorporate citizens' participation in successful projects?", we can conclude that developing citizens' participation was designed using a customer feedback model often employed in the industry. When companies sell products, they usually set up a customer service process to support customers and collect information and satisfaction data about the product. In the case of Bangkok, the Traffy Fondue platform is the city's digital customer service solution. The backend is linked to all the agencies responsible for fixing problems in the city, and the front provides the citizens with easy access to submit complaints. The complaints are problem reports. These reports consist of a GPS location, a photo, a case type selected from the types provided in the system, and a comment text section so the citizen can describe the observation and problem to solve. This process makes it easy to collect data and to build up various analytics for the city, for example, for repair and route planning and proactive repairs based on forecasting models. Additionally, a responsive system should give citizens feedback on their complaints, which provides a sense of belonging and increases the satisfaction levels for the citizens and the city management.

The Traffy Fondue data illustrate how inclusive the citizens are when reporting complaints. The high volume of reported

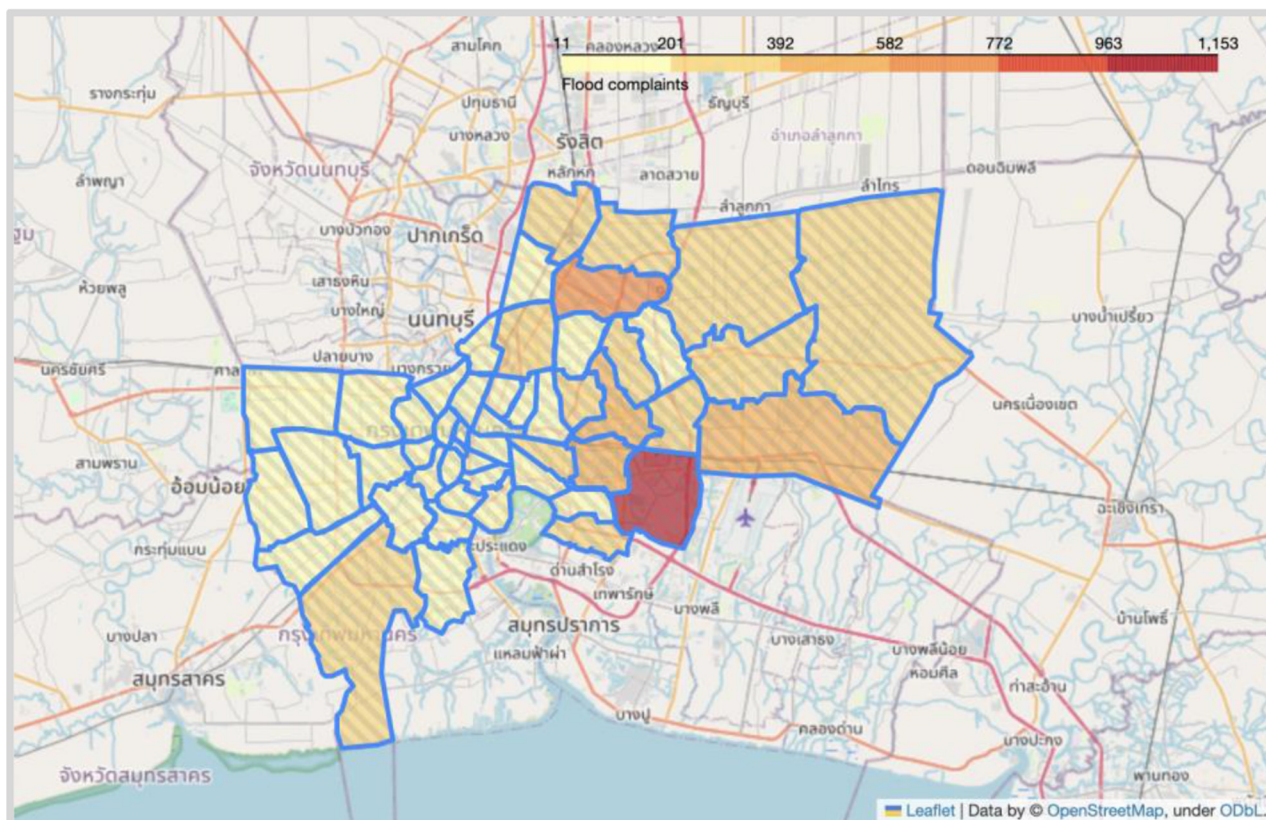


FIGURE 10
Geographical distribution of citizens' reports on problems related to floods. Source: authors.

complaints in the system shows that reports are gathered across all the districts in Bangkok. Figure 10 shows the city map with the highlighted districts to illustrate some of the complaint types. The map displays Flood complaints, while the darker colour indicates more complaints about floods.

Figure 11 shows the road complaints, with the darker colour indicating more complaints. The geographical information from the complaints, and in this case, consolidating the frequency into districts, will help identify the type of issues to focus on and the most impacted districts. Figure 9 illustrates the complaints about streetlights, again showing which district has the highest number of complaints.

The data must be used to analyse various scenarios of the city's situation while also providing a pulse on citizens' satisfaction with the city's infrastructure and services. A simple analysis in Figure 12 highlights that the highest number of complaints is related to road incidents, which suggests that citizens identify more road- or traffic-related issues during the initial stage of Traffy Fondue usage.

5.2 Value added by citizens and value incorporation process (RSQ2)

The research question outcome presents the results from the Traffy Fondue platform in the form of citizens' voices through the

data collected and the processes or workflows used to develop a responsive operation.

The launch of the Traffy Fondue platform drew significant citizen participation, with more than 1,700 complaints reported in just 1 day (see Figure 13). This ongoing engagement illustrates the platform's role in fostering collaboration between citizens and the city government, ultimately contributing to a more livable city.

As for citizen's access and participation, the roll-out and usage of the Traffy Fondue platform have been fine. However, on the back-end side, the staff managing or assigning the complaints to be fixed found that they needed some basic training to understand the workflow to ensure that complaints are redressed before changing the status to "finished". Overall, these are minor challenges being addressed through continuous improvement. Three factors contribute to the Traffy Fondue platform becoming an urban innovation and an inclusive city platform: (i) BMA's inclusive strategy for citizen participation, (ii) an intuitive user interface (UI) that makes it easy for citizens (as users) to use the digital platform, and (iii) a back-end automated workflow, that facilitates the easy adoption and operationalisation of the Traffy Fondue platform by responsible stakeholders and organisations.

The Traffy Fondue platform is also designed to provide citizens with feedback. There is a menu option where citizens can query and request the status of their submitted complaints. Some citizens explained how they used the Traffy Fondue platform to report complaints and have their problems redressed, for example, about

TABLE 3 Consolidated number of selected complaints over the study period across the districts in Bangkok.

District	Road	Side walk	Flood	Light	Safety	Cleanliness	Drain	Bridge	Obstruction	Traffic	Electric wires	Canal	Tree	Noise
Bang Bon	240	68	111	158	86	46	51	30	44	38	43	25	56	18
Bang Kapi	586	299	552	239	175	134	195	199	114	142	173	121	91	49
Bang Khae	537	318	197	268	152	174	129	94	162	121	91	59	94	35
Bang Khen	688	255	638	182	164	204	224	133	112	124	97	105	91	32
Bang Kho laen	239	94	47	60	76	111	70	57	53	32	52	29	52	56
Bang Khun Thian	679	159	373	114	204	103	126	130	76	84	68	74	68	50
Bang Na	465	324	348	145	124	135	162	58	97	76	63	45	69	66
Bang Phlat	253	182	71	131	120	104	87	110	89	48	80	34	52	26
Bang Rak	481	352	41	75	136	149	74	73	131	89	94	11	69	39
Bang Sue	454	206	84	254	149	140	108	169	86	101	87	45	59	48
Bangkok Noi	277	221	97	126	97	84	77	163	91	60	79	47	47	29
Bangkok Yai	108	66	21	66	52	32	28	29	42	19	38	50	27	7
Bueng Kum	305	143	231	107	81	397	94	81	66	50	66	113	85	26
Chatuchak	1,129	715	257	408	437	265	264	231	277	184	303	99	155	92
Chom Thong	273	141	90	145	151	93	95	70	102	62	69	54	53	22
Din Daeng	423	268	120	128	129	106	170	38	149	56	97	22	40	89
Don Mueang	424	97	239	104	99	115	86	59	48	47	51	32	33	22
Dusit	229	108	11	100	58	74	49	66	52	76	63	11	34	18
Huai Khwang	686	290	199	249	186	105	132	92	133	112	95	32	64	73
Khan Na Yao	175	83	90	83	64	52	34	44	34	33	52	39	17	11
Khlong Sam Wa	718	92	244	130	94	85	54	68	73	105	29	162	46	50
Khlong San	221	132	32	78	88	64	50	57	44	34	63	59	30	29
Khlong Toei	606	449	147	176	233	98	109	84	260	218	116	34	64	34
Ladprao	377	117	178	103	115	121	104	21	79	103	81	28	84	38
Laksi	351	144	153	115	102	137	90	55	54	43	72	46	51	20
Lat Krabang	1,159	262	555	164	204	139	141	242	50	136	61	173	56	59
Min Buri	408	125	216	121	100	87	56	151	121	71	46	33	24	36
Nong Chok	625	26	217	133	97	92	30	47	17	24	29	150	39	11
Nong Khaem	197	92	145	113	50	66	45	27	29	96	39	75	29	28

(Continued)

TABLE 3 (Continued)

District	Road	Side walk	Flood	Light	Safety	Cleanliness	Drain	Bridge	Obstruction	Traffic	Electric wires	Canal	Tree	Noise
Pathumwan	508	432	66	84	170	92	80	105	213	142	91	23	55	36
Phasi Charoen	295	211	57	114	91	113	80	83	73	25	101	72	73	27
Phayathai	417	217	49	193	129	121	127	139	118	59	92	24	39	32
Phra Khanong	329	172	190	191	78	70	122	31	47	37	79	37	59	28
Phra Na Khon	347	249	34	52	73	100	59	60	83	36	36	26	65	40
Pom Prap Sattru Phai	214	198	14	22	55	46	36	18	117	34	48	26	36	11
Prawet	823	239	1,153	251	170	343	214	118	99	81	80	191	94	60
Rat Burana	179	115	29	46	53	54	47	53	55	42	23	16	24	22
Ratchathewi	748	286	68	197	183	101	96	133	112	143	82	23	52	30
Sai Mai	461	77	260	106	120	293	82	44	43	75	64	104	56	20
Samphanthawong	102	50	20	12	14	17	17	1	36	11	26	5	7	4
Saphan Sung	481	81	366	104	91	120	44	103	29	65	40	58	39	22
Sathorn	466	215	77	106	105	110	113	53	113	75	64	17	47	36
Suan Luang	781	238	563	292	224	218	157	105	92	99	115	135	67	51
Taling Chan	422	99	116	163	104	92	95	93	43	51	79	24	61	13
Thawi Watthana	216	68	52	94	70	28	23	23	17	51	47	32	36	18
Thonburi	349	165	41	148	132	63	49	118	78	118	48	44	43	61
Thung Khru	218	58	162	49	53	77	72	32	51	59	26	30	39	15
Wang Thonglang	402	132	250	102	102	75	139	48	59	42	101	38	66	54
Wattana	699	534	277	163	266	126	208	40	221	252	181	50	75	59
Yannawa	412	159	88	124	109	80	61	142	101	70	48	24	35	40

Source: Authors.

the case of a missing bus stop. This complaint was resolved through a committee meeting, which cited another location. The citizen (as a user) was able to reopen the case, clarify the location, and explain how the bus stop may have been mistakenly removed. Some citizens expressed that Traffy Fondue has brought many positive experiences to the local communities. Citizens are notified about their complaints and feel more engaged with their city and its leadership. Many problems have been fixed, proving a significant difference from the old processes used in Bangkok.

The statistical data on the Traffy Fondue website (NecTec, 2022) shows a high satisfaction level of 84% among staff and

91% among the citizens-as-users. It indicates that Traffy Fondue has positively impacted Bangkok's mega-city and its citizens.

TABLE 4 List of categories of report types in Traffy Fondue.

1) Cleanliness, garbage	6) Damaged equipment and equipment	11) Help
2) Electricity and water supply	7) Risk points	12) Health
3) Broken streetlights	8) Disasters: floods, fires, Burns	13) Corruption Clues
4) Roads and sidewalks	9) Trees, Smells, Sounds, Animals	14) Others
5) Damaged buildings	10) Registration, Public Relations	

Source: Traffy Fondue website (NecTec, 2022).

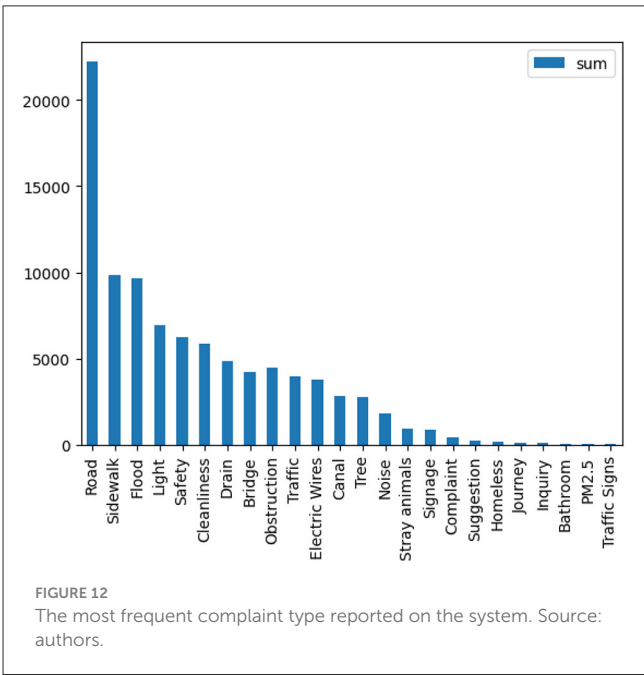
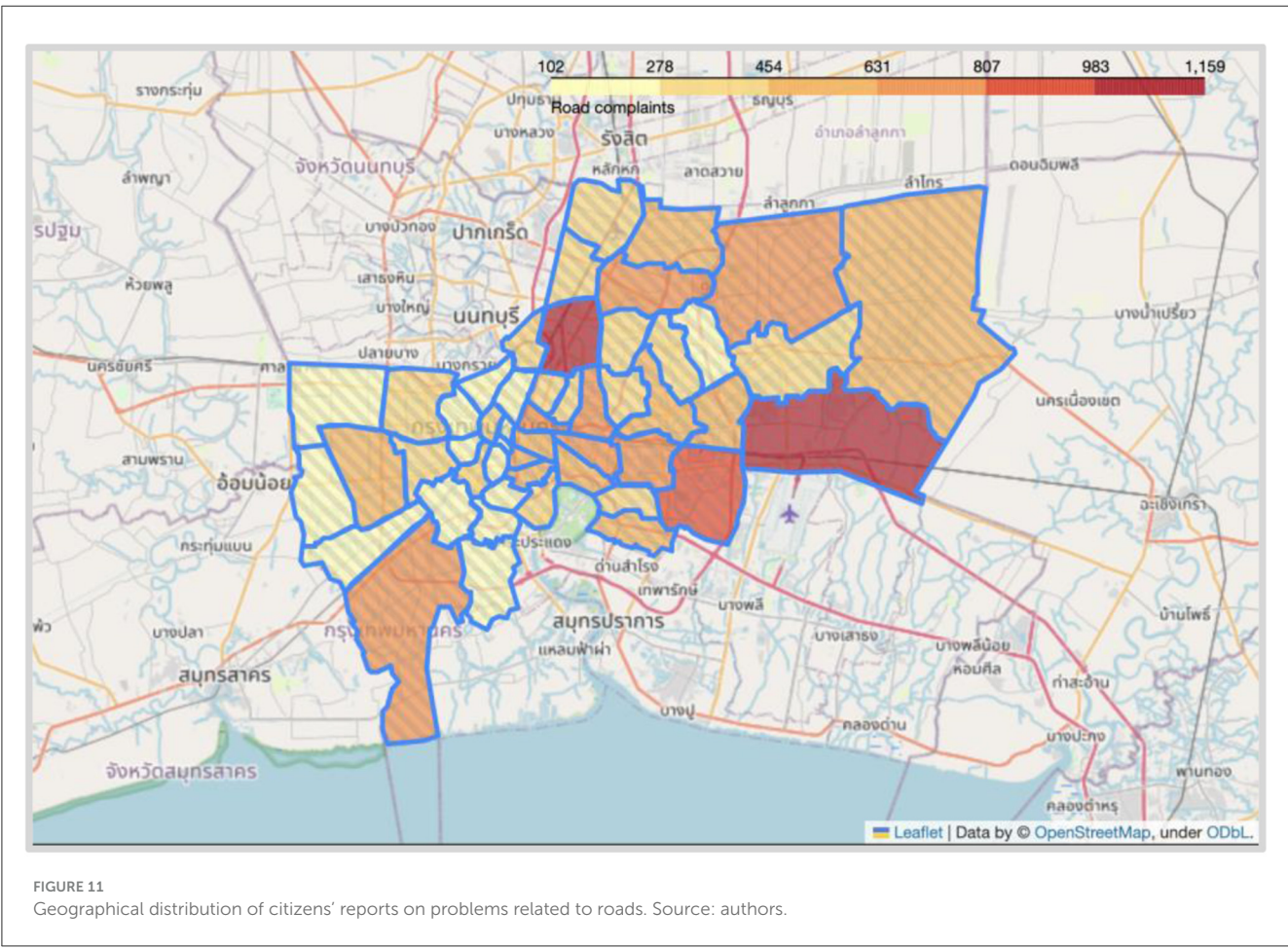
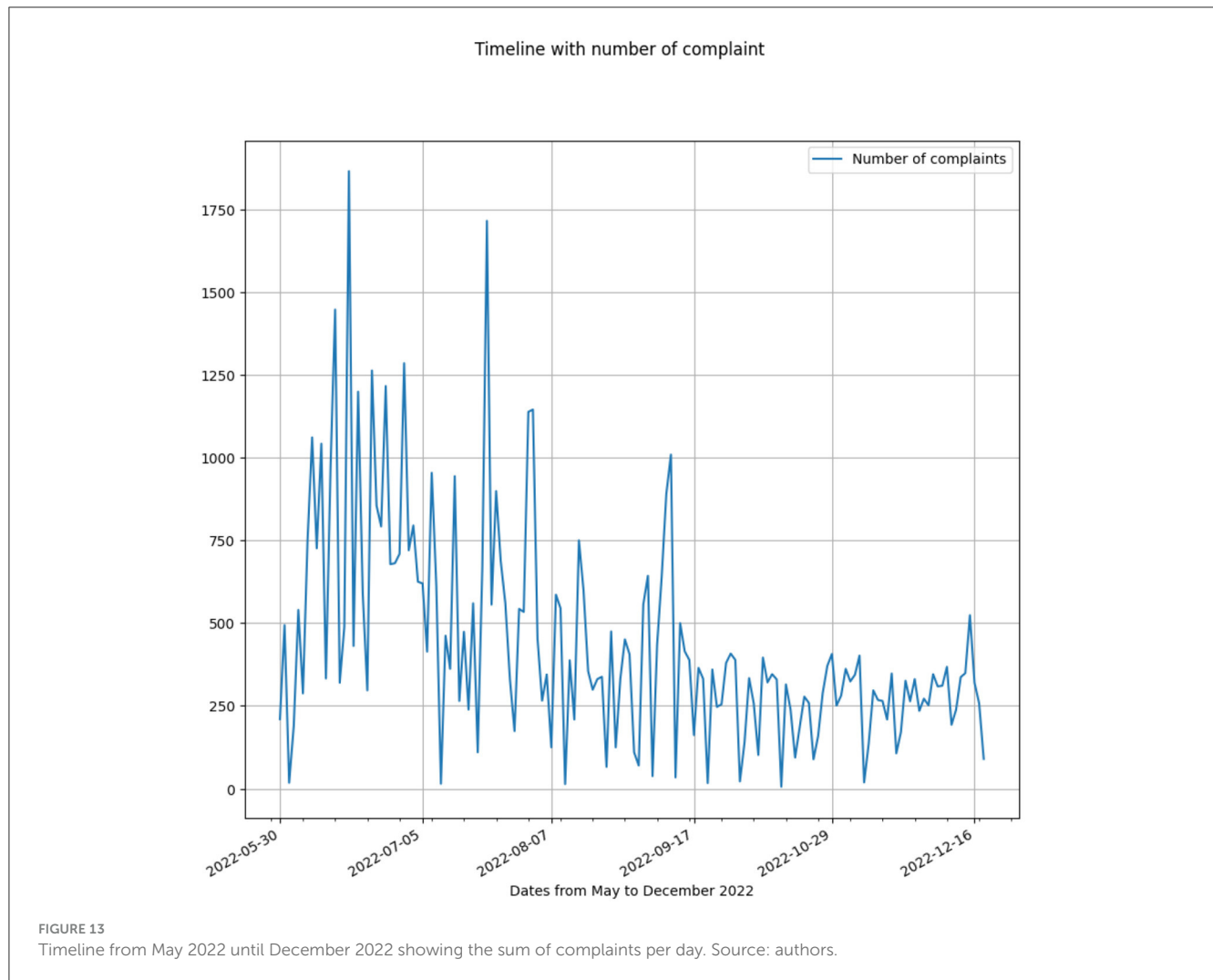


FIGURE 12 The most frequent complaint type reported on the system. Source: authors.





Moreover, Traffy Fondue is becoming a trusted platform as many organisations within Bangkok and other cities are increasing the usage. As of 2022, more than 1,754 organisations, 262 office buildings, and 577 town municipality offices across Thailand are using the Traffy Fondue. The platform has been available at no charge for local administrations for 3 years, valid from October 2022 until September 2025 (NSTDA, 2022). The automated workflow process has reduced the time to problem-solving to an average of 13 h and resulted in overall cost savings of 78 million Thai Baht (US \$2.14 million) annually. As of October 30, 2022, 173,238 cases were reported (Parpart, 2023), and 110,577 were resolved (see Figure 14). These reports are publicly available via the Traffy Fondue website (NecTec, 2022), illustrating total complaints, resolved, and pending cases.

Traffy Fondue encourages the participation process, which, in this case, is a chatbot that enables citizens to submit reports on problems related to urban infrastructure, services, and other issues. This chatbot, in the form of a digital 'smart city platform, seamlessly collects data from the reports received from the citizens. As data is received, the relevant local government agency processes the reports and takes action to redress the issue. Citizens will be notified once these issues are resolved and can provide feedback via the

same chatbot. This is where data collection becomes important, as further action in governance could take place to improve the citizens' experiences in the future.

The Traffy Fondue data provides information about locations in Bangkok where problems exist and need repair. It also includes information about citizens' needs and concerns in their communities, which leads to a more engaging relationship between citizens and the city administration through the smart city interface provided by Traffy Fondue. The most frequent complaints submitted by the citizens are related to "Road", "Sidewalk", and "Flood". The complaints/reports are usually severe, with expressions of profound respect to the public services that must resolve the problems. When browsing through some complaints on the platform, it is evident that some neighbourhoods need proactive measures to maintain the roads and sidewalks. The problems may have occurred from poorly executed repairs or heavy rainfall or traffic (see Figure 15), for an example from an actual citizen's report. Since the official launch of Traffy Fondue, the citizens of Bangkok have signed up with the chatbot and started reporting complaints to the city administration. The first few months saw a steep incline in submitted complaints, which levelled out to a steady daily average of around 360 complaints.

As the Traffy Fondue platform’s usage becomes more common in Bangkok and road repairs become more proactive, there may be a shift toward complaint types that will be in focus from the citizens’ point of view. Moreover, the sum of completed repairs or

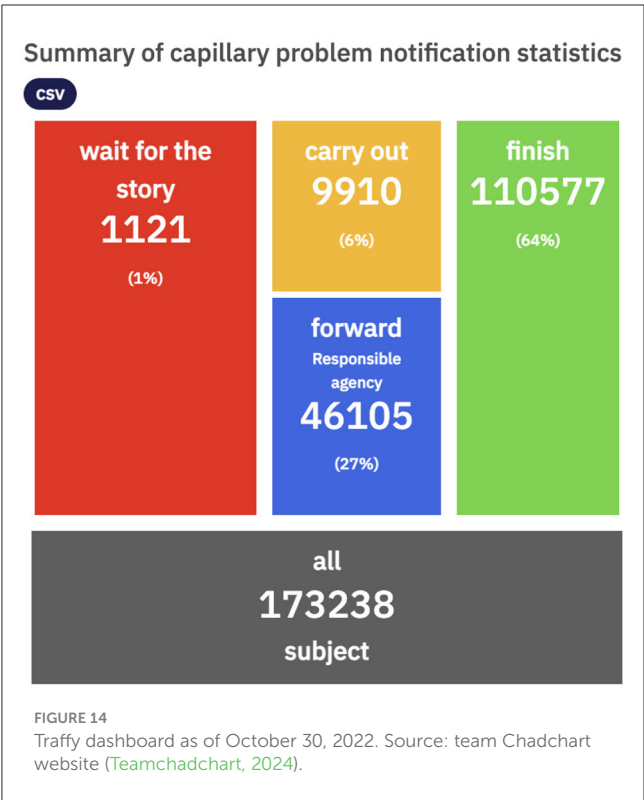
complaints indicates that the BMA is responding quickly to resolve the problems and make Bangkok a responsive city.

As a result, the Traffy Fondue platform has proven to provide value to citizens and the local government. It continues to add value as data is collected via the platform.

From Research Sub-question 2, “What value do citizens add to smart city projects that succeed?”, the smart city project, such as Traffy Fondue, enhances citizen participation. The ‘feedback registering mechanism’ collects information on how to improve the system. Given that the citizens often provide feedback, this ‘feedback registering mechanism’ could add great value to Bangkok or any other city becoming an inclusive city. There are at least two reasons for citizens’ inclusion contributing to the success of smart city projects:

Responsive City. This is how the city becomes a ‘responsive city’ when citizens can be informed about issues around the city. Citizens become part of the city ecosystem and continuously provide data, enabling city operations to act or plan.

Saving Resources. When citizens provide information about infrastructure issues or other problems, the city becomes proactive in its operations. This process saves resources including money and time for the city government, as citizens’ data collection provides information about the current state of the city and builds forecasting models for maintenance and planning.



5.2.1 Addressing digital divide measures in Traffy Fondue

While Traffy Fondue has significantly improved citizen engagement in urban governance through digital reporting, its reliance on mobile phones and internet access presents challenges for individuals without digital connectivity. The platform primarily functions as a smartphone-based complaint submission system,



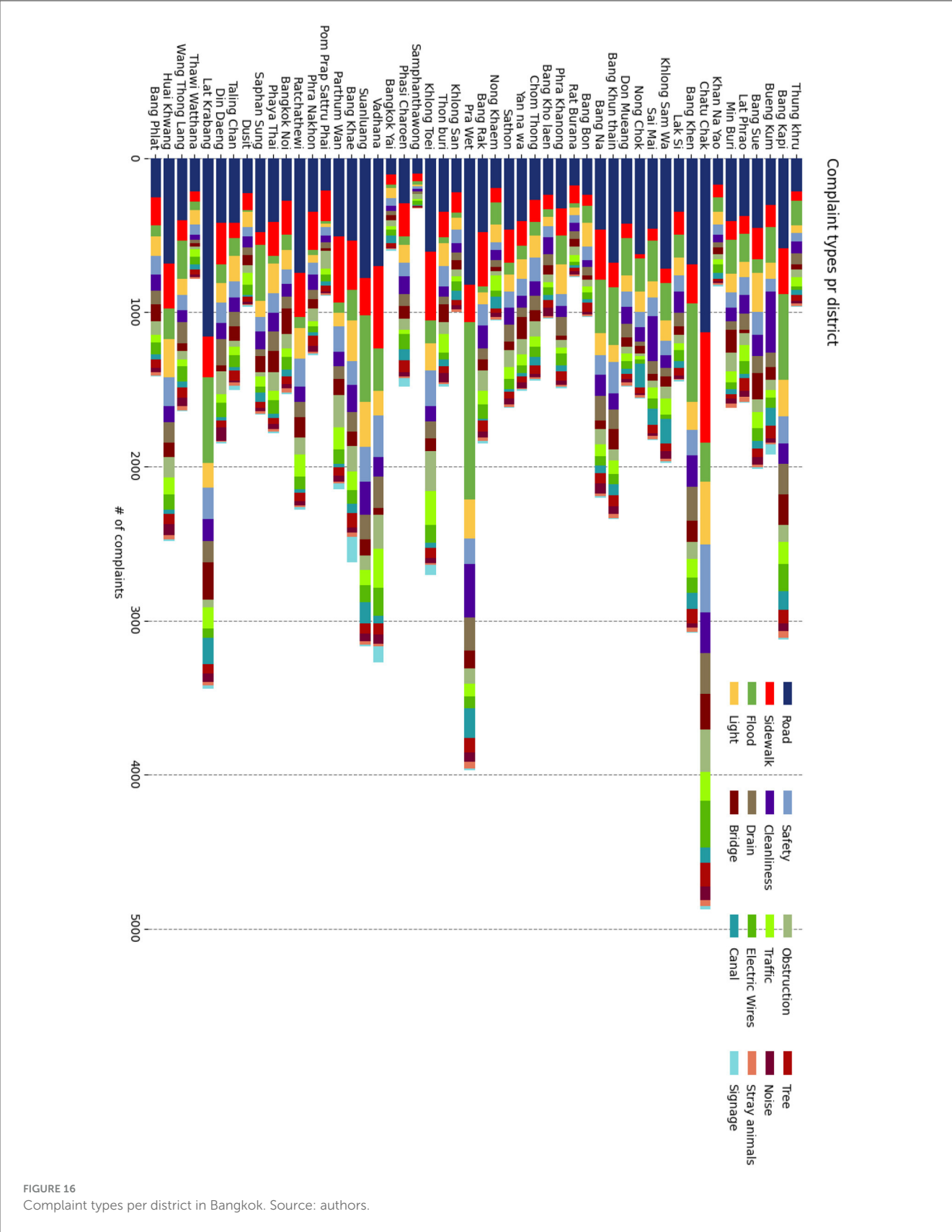


FIGURE 16
Complaint types per district in Bangkok. Source: authors.

TABLE 5 Smart city success factors and Traffy Fondue smart city innovation case study.

Categories	Success factors/criteria defined by Depa (2024)	Traffy Fondue smart city initiative and success criteria
Smart economy	Promote innovative environments	Innovative platform
	Industry and innovation	Fostering and encouraging innovation
	Availability of expertise and technology	
Smart environment	Health and wellbeing, environment	Bringing the citizens opinions as a value
	Development of sustainable policies	Contributes to environmental sustainability and governance by helping to report and resolve problems faster
	Environmental sustainability and governance	
	Sustainability	
Smart governance	Government transparency	Promote trust through data sharing
	Open data and datasets	Sharing of data and opportunities
	Data and effectiveness of data management systems	Automate complaints routing and resolution
		Data analytics to support planning
	Local Government to promote PPP	Collaboration with private sector service providers
	Alignment with government initiatives,	Developed to support the government initiatives
	Public policy, political strategy, focus on solving local issues	Citizens report about local issues to be solved
	Holistic smart city development,	Support city operation and long-term vision
	Long-term vision	
Smart living	Improving citizens' quality of life	Saves resources (money and time) by helping resolve municipal problems reported by citizens
	Personal privacy policies, security	Securing personal data
		Traffy Fondue facilitates communication between BMA and citizens
Smart mobility	Built infrastructure	
	Infrastructure framework	Citizens report on repair and maintenance or
	Mobility	Traffic violations
Smart people	People	
	Civic and social	Contributing to social inclusion
	Health and wellbeing, environment	Improve the city toward a liveable city

(Continued)

TABLE 5 (Continued)

Categories	Success factors/criteria defined by Depa (2024)	Traffy Fondue smart city initiative and success criteria
	Citizens-first mindset	Bringing the citizens' opinions as a value
	Human capacity building	Inclusion and mindful action from citizens

Source: authors.

making it inaccessible to citizens without smartphones, stable internet access, or digital literacy.

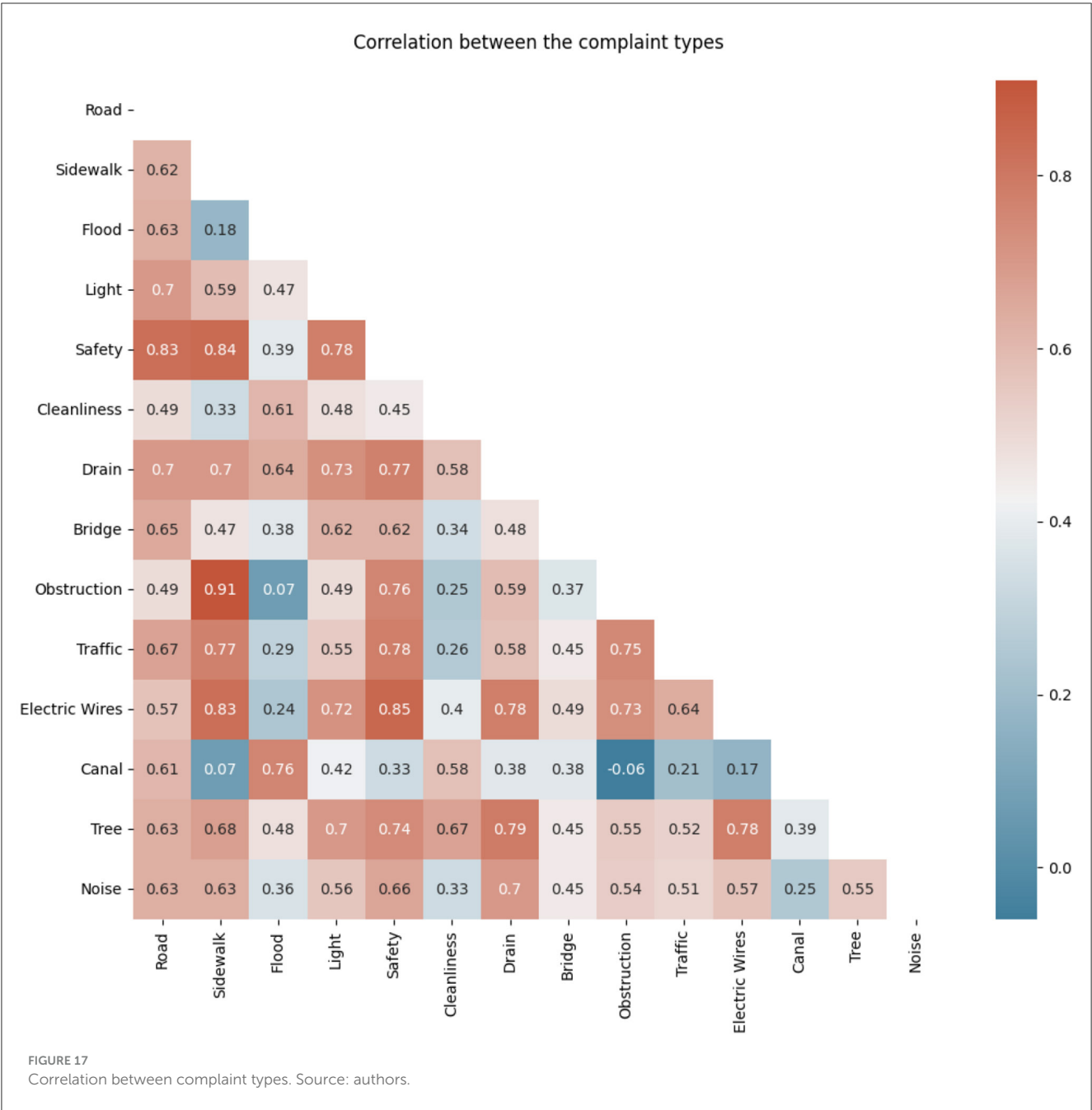
The study did not find any clear digital inclusion policies; some measures could have been incorporated into existing systems to offer alternative access points; For example allowing individuals who cannot use the app to submit complaints through telephone support or web-based platforms, or enabling citizens to file complaints in person. Other measures could be to enable community-assisted Complaint Submissions, where residents with digital access may assist digitally excluded individuals in submitting reports.

5.3 Synthesis of main research findings/Traffy Fondue and smart city criteria for success

The paper started with the main research question: why do smart city projects succeed with citizen participation? And what factors define the value proposition of a successful project? This section synthesises the main research findings on Traffy Fondue and the criteria for success in smart city projects.

The success factors from this study are analysed concerning the smart city categories defined by Depa (2024, Table 5). The Traffy Fondue platform is the smart city innovation project in focus, contributing to multiple factors: awareness, observation, inclusion, and feedback. These factors prove that citizens care about their city and are willing to play an inclusive role in improving their lives. The factors are recorded under smart economy, smart environment, smart governance, smart living, smart mobility, and smart people. These are the factors recorded from the study that are within the limitations of the Traffy Fondue platform. When more report categories are added to the platform, the citizens will have broader areas to submit reports on. Moreover, the opportunities are limitless, as the platform's open data structure gives citizens access to further innovation with data.

Table 5 highlights that the Traffy Fondue platform strongly emphasises government transparency by openly sharing data and fostering trust within the community. The platform enhances public accountability and strengthens citizen-government relationships by ensuring citizens have access to and can review critical information. Furthermore, Traffy Fondue adopts a citizen-centric approach, prioritising social inclusion by valuing public input and actively encouraging citizen participation. This alignment with community needs promotes engagement



and cultivates a sense of ownership and empowerment among residents.

Traffy Fondue enhances public-private partnerships (PPP) by collaborating with private-sector service providers. This partnership effectively leverages the combined strengths and resources of public and private entities, driving innovation and improving service delivery while demonstrating effective stakeholder management.

The platform emphasises health and wellbeing by raising awareness of environmental issues, thereby enhancing the city’s overall livability. This initiative fosters a healthier and more sustainable urban environment. Furthermore, Traffy Fondue upholds a long-term vision for the city’s growth,

integrating innovative initiatives to ensure sustainability. Moreover, the platform emphasises effective communication and the development of sustainable policies. By ensuring that all stakeholders are informed and engaged, Traffy Fondue supports the long-term sustainability of smart city initiatives and fosters a collaborative environment for continuous improvement.

Analysis of citizen complaint data reveals the primary types of complaints and their geographical distribution across districts. Figure 16 illustrates the breakdown of complaint types by district, indicating that “Pra Wet” has a notably high frequency of flood-related complaints. This pattern correlates with the geographical traits shown in Figure 10, highlighting potential environmental and infrastructural vulnerabilities in certain areas.

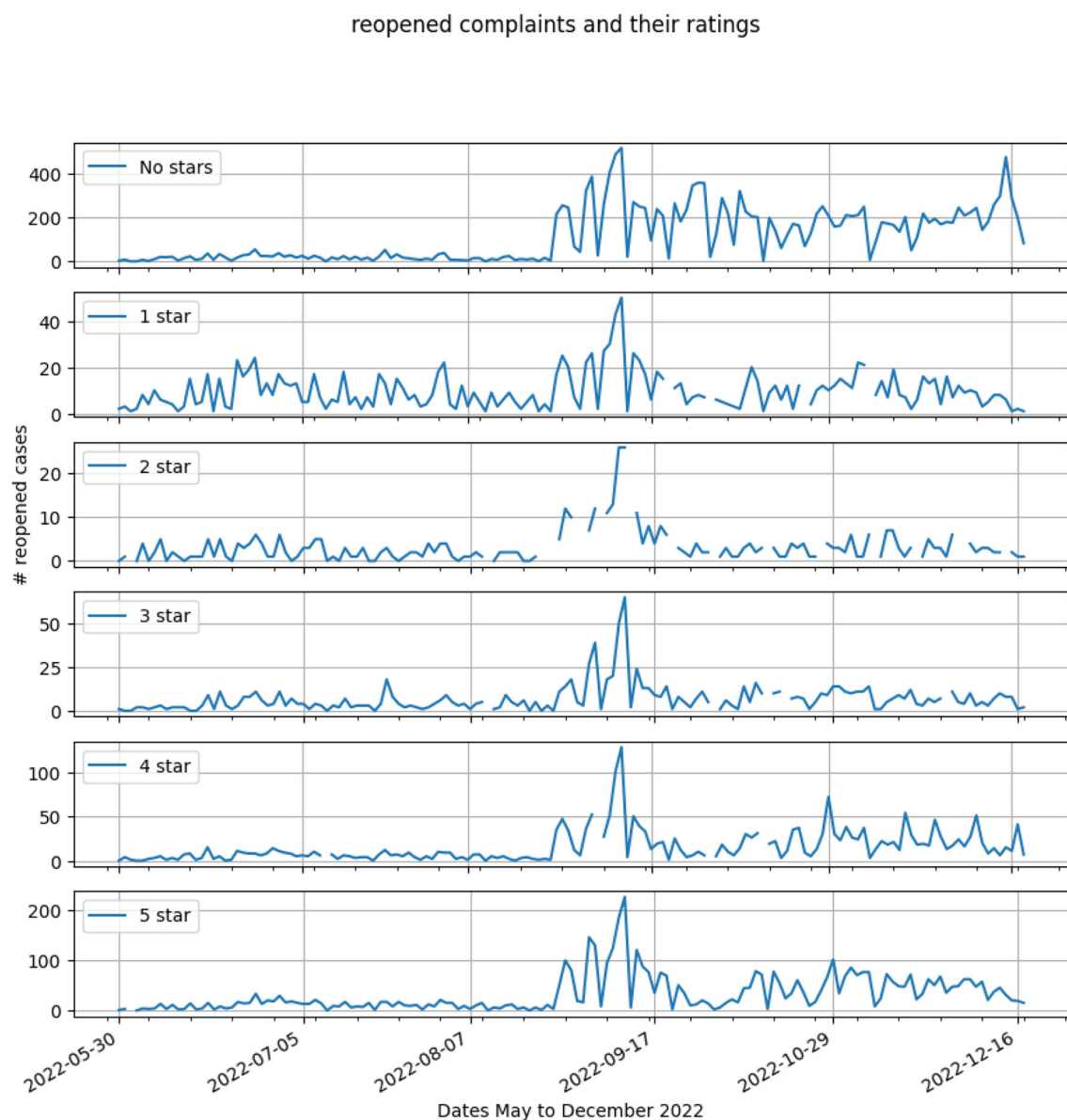


FIGURE 18
Ranging of complaint responses as they are fixed. Source: authors.

This data-driven approach provides an actionable foundation for local government agencies to implement targeted interventions tailored to district-specific needs. By focusing resources on areas with high complaint densities, agencies can enhance operational efficiency, resilience, and responsiveness. Additionally, analysing the correlation between complaint types, as visualised in the correlation diagram in Figure 17, offers insights into possible causal relationships. For instance, complaints about Roads, Sidewalks, and Lights are linked under the Safety category, indicating that infrastructural assessments may be necessary to address areas with inadequate lighting or sidewalk conditions that compromise safety. Another example includes the association between Safety and Obstruction complaints on Sidewalks, where sidewalk obstructions may pose safety hazards to pedestrians.

Furthermore, the relationship between canals and flood-related complaints underscores the potential impact of canal blockages on flooding incidents, suggesting a need for regular canal maintenance to mitigate flood risks.

Figure 18 indicates the complaints satisfaction level with the number of stars assigned to a case. The citizens report or rank the finished work with 0 to 5 stars; as the figure illustrates, the highest ranking is 4 and 5 stars. The figure also demonstrates that cases are re-opened. This means it shows the city is responding to citizens' follow-up complaints.

This study acknowledges limitations, particularly its reliance on 9 months of data, which may not capture seasonal or annual trends. Future research could benefit from an extended dataset, such as 2 years, to enable predictive modelling and trend analysis.

TABLE 6 Key factors that contributed to the success of the Traffy Fondue digital platform.

Success factors	Description
Government transparency and open data	The Traffy Fondue platform's use of open data built trust within the mega-city community by making information accessible and transparent to the citizens. This transparency ensured that the citizens felt involved and informed about the city's operations.
Citizen-first mindset	Emphasising a citizens-first approach promoted social inclusion and valued residents' opinions. This mindset was crucial for fostering a sense of ownership and involvement among citizens.
Public-private partnerships (PPP)	The collaboration between the public sector and private service providers enhanced the platform's efficiency and innovation. Leveraging the strengths of both sectors led to improved service delivery and innovative solutions to urban challenges.
Health and wellbeing initiatives	The Traffy Fondue platform raised awareness about environmental and health issues, contributing to a healthier and more sustainable urban environment. This focus supported Bangkok's overall livability and long-term sustainability goals.
Innovation and continuous improvement	The Traffy Fondue platform encouraged a culture of urban innovation by integrating advanced technology and effective data management systems. This approach addressed the emergent urban issues and promoted continuous improvement and adaptability to future challenges.
Effective communication and sustainable policies	Ensuring that all stakeholders were informed and engaged was essential for the long-term sustainability of the Traffy Fondue smart city initiative in Bangkok. The platform's emphasis on communication and policy development fostered a collaborative environment for continuous improvement and sustainable urban development.

Additionally, incorporating sentiment analysis of complaint text could provide a nuanced understanding of complaint severity, enhancing prioritisation in response strategies.

6 Conclusion

The present study explored the success factors of smart city projects, focusing on citizen participation and the Traffy Fondue platform implemented in the Bangkok mega-city, Thailand. This research addressed the main research question: “Why do smart city projects succeed with citizens’ participation?” and the sub-questions regarding the factors defining the value proposition of successful projects.

Based on this empirical study, the authors found that active citizen participation significantly benefited the success of the smart city initiative Traffy Fondue in the Bangkok mega-city. The platform’s design facilitated a seamless feedback loop where citizens could report issues, which city administrators promptly addressed. This ongoing interaction resolved immediate problems and allowed for long-term planning and proactive infrastructure maintenance, ultimately improving the quality of life for Bangkok’s residents. Table 6 gives an overview of the key factors that contributed to the success of Traffy Fondue.

The success of the Traffy Fondue platform highlighted the critical role of citizen participation in advancing smart city projects. Citizens’ active engagement through the platform addressed urban issues more effectively and strengthened trust between the community and urban governance structures. This study’s findings suggest that incorporating citizen feedback is essential for the success and long-term sustainability of smart city initiatives like Traffy Fondue in Bangkok’s mega-city context.

As of 2024, the platform has expanded significantly, reaching 1,608 municipalities and 1,899 sub-districts across Thailand (NecTec, 2024). This showcases its scalability and potential impact on urban governance nationwide.

However, it is essential to note that the dataset used for this study was limited to just 9 months of data, which constrained the ability to analyse longer-term trends and the full scope of citizen participation. Future studies should incorporate larger datasets from Traffy Fondue for a more comprehensive understanding of how citizen feedback contributes to urban problem-solving. Such studies can explore how location data and sentiment analysis enhance predictive models, enabling cities to address urban issues proactively. Researchers could also refine feedback mechanisms to improve the responsiveness of smart city systems. By integrating these lessons, cities and megacities can become more responsive, inclusive, resilient, and sustainable, thereby enhancing the efficiency of urban governance and improving the quality of life in the 21st century.

7 Limitation

His study on the Traffy Fondue open data platform in Bangkok has several limitations. First, the research began mid-2022, just a few months after the platform’s launch. As a result, the analysis was based on a relatively short data collection period of 9 months, which may only partially capture longer-term patterns, trends, or changes in user engagement and reporting behaviour over time. Second, this study exclusively focused on Bangkok, providing insights specific to the context of this city. Consequently, the findings may not be generalisable to other urban environments within Thailand or internationally.

Further studies across multiple cities and countries are recommended to explore potential correlations and contrasts in platform usage, effectiveness, and public engagement across diverse urban contexts. This broader scope could yield more comprehensive insights into the global applicability of open data platforms like Traffy Fondue.

Data availability statement

Publicly available datasets were analyzed in this study. This data can be found at: <https://github.com/motethansen/bkk-traffic-data>.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation

and institutional requirements. Written informed consent from the [patients/ participants OR patients/participants legal guardian/next of kin] was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

MH: Resources, Validation, Data curation, Visualization, Project administration, Methodology, Formal analysis, Software, Investigation, Writing – review & editing, Conceptualization, Supervision, Funding acquisition, Writing – original draft. BD: Supervision, Conceptualization, Methodology, Formal analysis, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

- Acharya, M., and Mohbey, K. K. (2025). Time-aware cross-domain point-of-interest recommendation in social networks. *Eng. Appl. Artif. Intell.* 139:109630. doi: 10.1016/j.engappai.2024.109630
- Adelina, C., Jenny Yi-Chen, H., and Lisa, S. (2021). *Enabling Inclusion in Smart City Development: A Policy Toolkit*. Stockholm: Stockholm Environment Institute, 25.
- Albino, V., Berardi, U., and Dangelico, R. M. (2015). Smart cities: definitions, dimensions, performance, and initiatives. *J. Urban Technol.* 22, 3–21. doi: 10.1080/10630732.2014.942092
- Aldegheishem, A. (2019). Success factors of smart cities: a systematic review of literature from 2000–2018. *TeMA. J. Land Use Mobility Environ.* 12, 53–64. doi: 10.6092/1970-9870/5893
- Angelidou, M., Psaltoglou, A., Komninos, N., Kakderi, C., Tsarchopoulos, P., Panori, A., et al. (2017). Enhancing sustainable urban development through smart city applications. *J. Sci. Technol. Policy Manage.* 9, 146–169. doi: 10.1108/JSTPM-05-2017-0016
- Anthopoulos, L., Janssen, M. F. W. H. A., and Weerakkody, V. (2018). “A unified smart city model (USCM) for smart city conceptualization and benchmarking,” in *E-Planning Collaborative* (Hershey, PA: IGI Global), vol. 1–3. doi: 10.4018/978-1-5225-5646-6.ch025
- Arnstein, S. R. (1969). A ladder of citizen participation. *J. Am. Inst. Planners* 35, 216–224. doi: 10.1080/01944366908977225
- Bastos, D., Fernández-Caballero, A., Pereira, A., and Rocha, N. P. (2022). Smart city applications to promote citizen participation in city management and governance: a systematic review. *Informatics* 9:4. doi: 10.3390/informatics9040089
- Becker, J., Friedrich, C., Michael, R., Daniel, B., Jennifer, P., Jan vom, B., et al. (2023). City 5.0: citizen involvement in the design of future cities. *Electron. Mark.* 33:10. doi: 10.1007/s12525-023-00621-y
- Bradshaw, R., and Kitchin, R. (2022). Charting the design and implementation of the smart city: the case of citizen-centric bikeshare in Hamilton, Ontario. *Urban Geog.* 43, 567–588. doi: 10.1080/0272021.1878439
- Bruegge, F. (2021). *Smart Cities of the Future: 7 Things That Successful Cities Do*. IoT Analytics. Available online at: <https://iot-analytics.com/smart-cities-future-7-things-successful-cities-do/>
- Cardullo, P., and Kitchin, R. (2019). Being a citizen in the smart city: up and down the scaffold of smart citizen participation in Dublin, Ireland. *Geof.* 84, 1–13. doi: 10.1007/s10708-018-9845-8
- Chantry, W. (2022). Built from the internet up: assessing citizen participation in smart city planning through the case study of Quayside, Toronto. *Geof.* 88, 1619–1637. doi: 10.1007/s10708-022-10688-3
- Correia, D., Lourenço Marques, J., and Teixeira, L. (2021). City@path: a collaborative smart city planning and assessment tool. *Int. J. Trans. Dev. Integr.* 6, 66–80. doi: 10.2495/TDI-V6-N1-66-80
- Crompton, C. D., Wongthanavasu, S., Kamnuansilpa, P., Draper, J., and Bialobrzeski, E. (2021). Assessing the ASEAN smart cities network (ASCN) via the quintuple helix innovation framework, with special regard to smart city discourse, civil participation, and environmental performance. *Int. J. Urban Sustain. Dev.* 13, 97–116. doi: 10.1080/19463138.2020.1827411
- Daniel, C. J. Y., Wahid, N. A., and Tan, C. L. (2020). Why smart leaders are important in smart city development—a conceptual framework. *Int. J. Indus. Manage.* 5, 1–9. doi: 10.15282/ijim.5.0.2020.5617
- Das, D. K. (2024). Exploring the symbiotic relationship between digital transformation, infrastructure, service delivery, and governance for smart sustainable cities. *Smart Cities* 7:2. doi: 10.3390/smartcities7020034
- Depa (2022). *Depa Thailand - digital man power*. Available online at: <https://www.dep.or.th/en/digitalmanpower/smartcity> (accessed October 29, 2022).
- Depa (2024). *Smart city plan: smart city office*. Available online at: <https://www.dep.or.th/en/smart-city-plan/smart-city-office> (accessed March 17, 2024).
- Dooley, K. (2021). Direct passive participation: aiming for accuracy and citizen safety in the era of big data and the smart city. *Smart Cities* 4:1. doi: 10.3390/smartcities4010020

- Fernandez, V., and Pérez, V. (2024). A new approach to interoperability within the smart city based on time series-embedded adaptive traffic prediction modelling. *Netw. Spat. Econ.* 1–16. doi: 10.1007/s11067-024-09662-y
- Fernando, B. (2021). Smart cities of the future: 7 things that successful cities do. *IoT Analytics*. Available online at: <https://iot-analytics.com/smart-cities-future-7-things-successful-cities-do/>
- Forrester, J. W. (1989). *The Beginning of System Dynamics*. MIT System Dynamics Group Memo D. Available online at: www.clexchange.org
- Giffinger, R., Christian, F., Evert, M., Hans, K., Robert, K., and Nataša P. M. (2007). *Smart cities ranking of European medium-sized cities*. Available online at: https://www.researchgate.net/publication/261367640_Smart_cities_-_Ranking_of_European_medium-sized_cities (accessed November 6, 2024).
- Goodman, E. P., and Powles, J. (2019). *Urbanism Under Google: Lessons from Sidewalk Toronto*. Rochester, NY: Elsevier. doi: 10.2139/ssrn.3390610
- Guenduez, A. A., Singler, S., Tomczak, T., Schedler, K., and Oberli, M. (2018). Smart government success factors. *Yearbook Swiss Admin. Sci.* 9:96. doi: 10.5334/ssas.124
- Hansen, Michael, M., Kitt, K., and Ville, K. (2025). How can data contribute to smart city innovation: a study from thailand's smart city initiatives. *Front. Sustain. Cities*. 6:1473123. doi: 10.3389/frsc.2024.1473123
- Hartley, K., Woo, J. J., and Chung, S. K. (2018). Urban innovation policy in the postdevelopmental era: lessons from Singapore and Seoul. *Asia Pac. Policy Stud.* 5:599–614. doi: 10.1002/app5.255
- Hollands, R. G. (2015). Critical interventions into the corporate smart city. *Cambridge J. Reg. Econ. Soc.* 8, 61–77. doi: 10.1093/cjres/rsu011
- Iamtrakul, P., and Klaylee, J. (2019). “Lesson learns of success factors from 10 smart cities development: Thailand context,” in *2019 First International Conference on Smart Technology and Urban Development (STUD)*, (New York, NY: IEEE), 1–6. doi: 10.1109/STUD49732.2019.9018765
- Irvine, K. N., Asan, S., Fa, L., Hansa, S., Massimo, I., Peeradorn, K. et al. (2022). Smart city Thailand: visioning and design to enhance sustainability, resiliency, and community wellbeing. *Urban Sci.* 6:1. doi: 10.3390/urbansci6010007
- Jang, S., and Gim, T.-H. T. (2022). Considerations for encouraging citizen participation by information-disadvantaged groups in smart cities. *Sustain. Cities Soc.* 76:103437. doi: 10.1016/j.scs.2021.103437
- Jayasena, N. S., and Mallawaarachchi, H. (2019). “A critical review on the drivers and barriers for enabling smart city,” in *Proceedings of the International Conference on Industrial Engineering and Operations Management Bangkok, Thailand, March 5-7, 2019* (IEOM Society International), 9.
- José, R., and Rodrigues, H. (2024). A review on key innovation challenges for smart city initiatives. *Smart Cities* 7:1. doi: 10.3390/smartcities7010006
- Joyce (2022). *© Social Media Penetration in Thailand [Research]*. Digital Business Lab Hong Kong, Singapore. Digital Business Lab.
- Kaluarachchi, Y. (2022). Implementing data-driven smart city applications for future cities. *Smart Cities* 5:2. doi: 10.3390/smartcities5020025
- Kaszkur, A., and Kapsa, I. (2019). Citizens inclusion in the political decision-making process as a determinant of sustainable development implementation. *Eur. J. Sustainable Dev.* 8:4. doi: 10.14207/ejsd.2019.v8n4p363
- Kaur, S., John, L., and Damien, D. (2021). *Bridging the Digital Divide*. Munich: Roland Berger.
- Kemp, S. (2022). *Digital 2022: Thailand. DataReport—global digital insights*. Available online at: <https://datareportal.com/reports/digital-2022-thailand> (accessed November 30, 2022).
- Lee, J. Y., Woods, O., and Kong, L. (2020). Towards more inclusive smart cities: reconciling the divergent realities of data and discourse at the margins. *Geogr. Compass* 14:e12504. doi: 10.1111/gec3.12504
- Lim, S. S., and Zainal, S. S. (2022). Bridging Singapore's digital divides: making our smart nation smarter. *Introduction and Background*. Singapore: World Scientific. doi: 10.1142/9789811247750_0026
- Lin, Y. (2024). Long-term traffic flow prediction using stochastic configuration networks for smart cities. *IECE Trans. Intell. Syst.* 1, 79–90. doi: 10.62762/TIS.2024.952592
- Lyu, J., Hamzah, H., and Tedong, P. A. (2022). A framework for the analysis of urban innovation in smart cities: literature review findings. *Plann. Malays.* 20, 122–137. doi: 10.21837/pm.v20i24.1188
- Malek, J. A., Lim, S. B., and Yigitcanlar, T. (2021). Social inclusion indicators for building citizen-centric smart cities: a systematic literature review. *Sustainability* 13:1. doi: 10.3390/su13010376
- Mata, F., Verdejo, A., Pérez, L., and Porcel, C. (2021). A preliminary study of a citizen participation system based on consensus for decision-making processes. Presented at the *Hawaii International Conference on System Sciences* (University of Hawaii, Hamilton Library). doi: 10.24251/HICSS.2021.234
- Mills, D. E., Izadgoshasb, I., and Pudney, S. G. (2021). Smart city collaboration: a review and an agenda for establishing sustainable collaboration. *Sustainability* 13:16. doi: 10.3390/su13169189
- Mohanty, S. P., Choppali, U., and Kougianos, E. (2016). Everything you wanted to know about smart cities: the internet of things is the backbone. *IEEE Consum. Electron. Mag.* 5, 60–70. doi: 10.1109/MCE.2016.2556879
- NecTec (2022). Home - NECTEC: National Electronics and Computer Technology Center. Available online at: <https://www.nectec.or.th/en> (accessed October 21, 2022).
- NecTec (2024). *Traffy Fondue*. Fondue. Available online at: <https://www.traffy.in.th/>
- Nielsen, B. F., Baer, D., Gohari, S., and Junker, E. (2019). *The Potential of Design Thinking for Tackling the Wicked Problems of the Smart City*. CORP - Competence Center of Urban and Regional Planning.
- NSTDA (2022). *Traffy Fondue Platform to Enhance Efficiency of Public Services - NSTDA Eng*. Pathum Thani: National Science and Technology Development Agency.
- Parpart, E. (2023). *Chadcharts 6 Months in Office Were Marked by Increasing Transparency and Efficiency of Agencies*. Thai Enquirer.
- Pornwasin, A. (2022). *Traffy Fondue Helps to Make Thai Cities More Livable*. The Story Thailand.
- Przebylłowicz, E., Cunha, M. A., Geertman, S., Leleux, C., Michels, A., Tomor, Z. et al. (2022). Citizen participation in the smart city: findings from an international comparative study. *Local Gov. Stud.* 48, 23–47. doi: 10.1080/03003930.2020.1851204
- Rattanasavee, P. (2022). *Bangkok's New Governor Is Sending Shockwaves Through Thailand's Political Landscape*. The Diplomat.
- Resilientcities (2017). *Bangkok-resilience-strategy-english.pdf*. Available online at: https://resilientcitiesnetwork.org/downloadable_resources/Network/Bangkok-Resilience-Strategy-English.pdf (accessed April 12, 2024).
- Roengtam, S. (2020). *Inclusive Smart City Development: A Lesson Learned from Thailand*. Rochester, NY: Elsevier. doi: 10.2139/ssrn.3528982
- Roth, K., Dietfried, G., Christiane, R., and Anne-Katrin, N. (2020). Living up to the expectations: the effect of design thinking on project success. *Creativity Innovation Manage.* 29, 667–684. doi: 10.1111/caim.12408
- Rugkhan, N. T., and Murray, M. J. (2019). Songdo IBD (International Business District): Experimental Prototype for the City of Tomorrow? *Int. Plann. Stud.* 24, 272–292. doi: 10.1080/13563475.2019.1650725
- Sangkeetrakarn, G. C. (2022). *Traffy × TeamChadchart = Text Understanding*. NECTEC.
- Secinaro, S., Brescia, V., Calandra, D., and Biancone, P. (2021). Towards a hybrid model for the management of smart city initiatives. *Cities* 116:103278. doi: 10.1016/j.cities.2021.103278
- Shamsuzzoha, A., Juha, N., Sujana, P., and Kendall, R. (2021). Smart city for sustainable environment: a comparison of participatory strategies from Helsinki, Singapore, and London. *Cities* 114:103194. doi: 10.1016/j.cities.2021.103194
- Sharifi, A. (2022). Smart city indicators: towards exploring potential linkages to disaster resilience abilities. *APN Sci. Bull.* 12, 75–89. doi: 10.30852/sb.2022.1873
- Smith, A., and Martín, P. P. (2021). Going beyond the smart city? Implementing technopolitical platforms for urban democracy in madrid and barcelona. *J. Urban Technol.* 28, 311–330. doi: 10.1080/10630732.2020.1786337
- Suebvises, P. (2018). Social capital, citizen participation in public administration, and public sector performance in Thailand. *World Dev.* 109, 236–248. doi: 10.1016/j.worlddev.05.007
- Teamchadchart (2024). *#Traffy x TeamChadChart*. Available online at: <https://share.traffy.in.th/teamchadchart> (accessed April 14, 2024).
- Thai PBS World (2022). *Traffy Fondue: Nothing to Do with Cheese - But Melting Away Bangkokians' Problems*. Bangkok: Thai PBS World.
- Thai PBS World (2024). *From MIT to BMA: How New Governor Chadchart Is Turning Bangkok into a Smart City*. Bangkok: Thai PBS World.
- Tortermvasana, K. (2024). *NBTC Rolls out AI-Driven Complaints Channel*. Bangkok: Bangkok Post.
- Traffy: Privacy Policy (2022). Available online at: <https://neo-fondue.traffy.in.th/legal/privacy-policy/> (accessed May 30, 2022).
- United Nations (2019). *The Future of Asian and Pacific Cities: Transformative Pathways Towards Sustainable Urban Development*. Bangkok, Thailand: United Nations, ESCAP.
- United Nations (2023). *The Future of Asian and Pacific Cities 2023: Crisis Resilient Urban Futures*. Bangkok: ESCAP.
- Vinod Kumar, T. M., and Dahiya, B. (2017). “Smart economy in smart cities,” in *Smart Economy in Smart Cities: International Collaborative Research: Ottawa, St. Louis, Stuttgart, Bologna, Cape Town, Nairobi, Dakar, Lagos, New Delhi, Varanasi, Vijayawada, Kozhikode, Hong Kong, Advances in 21st Century Human Settlements* ed. T. M. Vinod Kumar (Singapore: Springer), 3–76. doi: 10.1007/978-981-10-1610-3_1

- Voelz, A., Muck, C., Amlashi, D. M., and Karagiannis, D. (2023). Citizen-centric design of consumable services for smart cities. *Digital Gov. Res. Pract.* 4, 1–18. doi: 10.1145/3597420
- Voorberg, W. H., Bekkers, V. J. J. M., and Tummers, L. G. (2015). A Systematic Review of Co-Creation and Co-Production: Embarking on the Social Innovation Journey. *Pub. Manage. Rev.* 17, 1333–57. doi: 10.1080/1472014.930505
- Wancharoen, S. (2024). *Traffic Woes Top Complaints on Traffy Fondue*. Bangkok: Bangkok Post.
- Whitehead, N. P., Scherer, W. T., and Smith, M. C. (2015). Systems thinking about systems thinking: a proposal for a common language. *IEEE Syst. J.* 9, 1117–1128. doi: 10.1109/JSYST.2014.2332494
- World Economic Forum (2023). *Sustainable Financing of Cities: 4 Success Factors from India's Smart City Mission Experience*. Geneva: World Economic Forum.
- Xu, H., and Zhu, W. (2021). Evaluating the Impact Mechanism of Citizen Participation on Citizen Satisfaction in a Smart City. *Environ. Plann. B Urban Anal. City Sci.* 48, 2466–80. doi: 10.1177/2399808320980746
- Xu, Y., Yang, G., Yi, W., and Cheng, K. (2021). *Critical Success Factors of Smart City Projects: Evidence from New Zealand*. Philippines.
- Zamani, A., Shayan, A., and Hassanzadeh, A. (2023). Participation development in responsive city with self-organizing approach (the case of Tehran city). *Cities* 143:104586. doi: 10.1016/j.cities.2023.104586
- Zheng, L., Kwok, W.-M., Aquaro, V., and Qi, X. (2019). “Digital government, smart cities and sustainable development,” in *Proceedings of the 12th International Conference on Theory and Practice of Electronic Governance* (New York, NY: Association for Computing Machinery), 291–301. doi: 10.1145/3326365.3326403