Enhancing Phitsanulok City Development Through Digital Economy: A Case Study of the Osaka Model

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Abstract

This research addresses the urgent challenge facing Phitsanulok, a rapidly growing secondary city in Thailand. To gather in-depth insights, the researchers conducted semi-structured interviews with 20 key informants in Phitsanulok city comprising five local government officials, five digital-technology entrepreneurs, five representatives from educational institutions and five community and business association leaders selected through purposive sampling to ensure representation of diverse stakeholder perspectives. Each 30-60-minute interview was audio-recorded, transcribed, and analyzed using Braun and Clarke's (2006) six-phase thematic analysis framework. The study finds out the essential components for successful digital transformation in Phitsanulok's specific context. The research emphasizes that effective implementation requires careful consideration of local conditions rather than a one-size-fits-all approach. Three critical success factors emerge: developing scalable digital infrastructure, establishing public-private partnerships that align with local business practices, and providing comprehensive digital skills training across the community. The study identifies engaging growth opportunities in agriculture, tourism, and e-commerce, leveraging Phitsanulok's existing strengths. To capitalize on these opportunities, the research proposes several strategic initiatives: establishing a dedicated digital economy office, implementing regulatory sandboxes for innovation, developing industry-specific clusters, and updating educational curricula to meet emerging workforce demands. The findings emphasize that Phitsanulok can achieve sustainable digital transformation by taking an adaptive approach that honors its unique identity while embracing technological advancement. This balanced strategy aims to creating regulatory sandboxes, foster economic growth while preserving the city's distinctive characteristics and ensuring broad community participation in the digital economy.

Keywords: Digital Economy, Phitsanulok, Osaka Model, Smart Cities, Public-private Partnerships, Regulatory Sandboxes

Introduction

The rapid advancement of digital technology has fundamentally transformed urban development paradigms worldwide, presenting both opportunities and challenges for secondary cities seeking to enhance their economic competitiveness (World Bank, 2024). Phitsanulok, a strategic city in Thailand's lower northern region, stands at a crucial juncture where digital transformation could potentially catalyze its development trajectory. This study examines the feasibility of implementing digital economy initiatives in Phitsanulok by analyzing the successful digital transformation framework of Osaka, Japan, which has emerged as a leading smart city model in Asia (Yamamoto et al., 2024).

The digital economy, characterized by the integration of digital technologies into business operations, public services, and urban infrastructure, has become a key driver of urban growth and sustainability (Zhao et al., 2023). While metropolitan areas like Bangkok have made significant strides in digital transformation, secondary cities like Phitsanulok face unique challenges in implementing comprehensive digital initiatives. These challenges include infrastructure readiness, digital literacy gaps, and the need for substantial investment in technological capabilities (Ministry of Digital Economy and Society, 2016).

Phitsanulok was selected as the focus of this study because it occupies a strategic position at the crossroads of northern and central Thailand, serving as a vital transportation and logistics hub, and it hosts multiple universities

and research institutes that supply the human capital and institutional partnerships necessary for piloting digital-economy initiatives. Its well-preserved cultural heritage and thriving tourism sector provide unique opportunities to integrate digital platforms with heritage management, while the provincial government's proactive launch of e-governance and smart-city pilots demonstrates strong local commitment. Moreover, Phitsanulok's moderate population size, diversified SME base in agriculture and services, and rising digital literacy make it broadly representative of Thailand's secondary cities yet sufficiently scaled to adapt and test the Osaka model's strategies effectively.

The Osaka model is built around two interlocking pillars—Public-Private Partnerships (PPPs) and smart-city innovation—and offers a clear roadmap for sustainable, resilient urban growth. First, Osaka has leveraged PPPs and targeted investment policies to co-fund high-speed networks, IoT sensor arrays, and open data platforms, using streamlined regulations and tax incentives to attract private capital. Second, it has localized Japan's "Society 5.0" vision through the Osaka Innovation Hub and related high-tech clusters, nurturing over 200 startups, supporting citizen-centric Big Data and governance dashboards, and rolling out comprehensive digital skills programs. The researchers chose this model for Phitsanulok because both cities function as regional commercial hubs, share similar development challenges—limited infrastructure, gaps in digital literacy, and the need for diversified economies—and operate within national agendas that prioritize high-technology clusters (Thailand 4.0 and Society 5.0). By examining Osaka's governance structures (e.g., regulatory sandboxes), its innovation-ecosystem development, and its PPP frameworks, we can identify context-sensitive strategies and plans that Phitsanulok can adapt to bridge the digital divide, boost competitiveness, and foster inclusive, community-driven digital transformation.

Osaka Model was referred to the concepts depending on the development of urban planning. The research strategies related to Osaka's smart city and infrastructure models. An important feature for Osaka city was smart city initiatives which were implementing and integrating digital technologies (eg. IoT, Big Data) to improve efficiency, sustainability, and quality of life. This research applied Osaka's principles and focused on 1) investment and Public-Private Partnerships (PPP), and 2) smart economy & digital transformation by expand Thailand 4.0 policies for high-tech industrial clusters in the model which included investment policy, infrastructure funding, smart city roadmap and sustainability & resilience (Almulhim, 2025; Gkontzis et al., 2024; Villani et al., 2025; Zhuo et al., 2025).

Osaka's development model presents a particularly relevant case study for Phitsanulok although Phitsanulok and Osaka each possess a distinct character, they also share several parallel characteristics in their digital economy strategies, including its historical role as a regional commercial hub and its strategic location within its respective national context. The Osaka model demonstrates how medium-sized cities can leverage digital technologies to enhance urban services, boost economic productivity, and improve quality of life while maintaining cultural identity and social cohesion (Machado et al., 2023). Of particular interest is Osaka's successful implementation of digital platforms for Small and Medium Enterprises (SMEs), smart city infrastructure, and citizen engagement initiatives.

Table 1 Baseline Comparison of Osaka (2020) and Phitsanulok (2021-2022)

Aspect	Osaka (2020 Baseline)	Phitsanulok (2021-2022)
City Population	2,752,412	62,584
Urban/Metro Population	19,165,000 (Keihanshin metro area)	281,929 (Phitsanulok urban area)
Nominal GDP	¥19,516.2 billion	THB 96,103 million
GDP Per Capita	US$ 59,958	THB 93,050
Digital-Initiative Funding	Early smart-city pilots funded via national subsidies & PPPs	Provincial e-governance and smart-city pilot budgets
Alignment with National Agenda	Japan's "Society 5.0" & Abenomics digitization reforms	Thailand 4.0 & emerging provincial digital-economy roadmap

This research aims to analyze the key success factors of Osaka's digital transformation and assess their applicability to Phitsanulok's context, considering local socio-economic conditions, existing infrastructure, and development goals. The study employs qualitative assessment of stakeholder perspectives and institutional readiness. Special attention is given to the potential adaptation of Osaka's digital governance frameworks, innovation ecosystem development, and public-private partnership models to Phitsanulok's unique circumstances (Junaidi, 2024).

Literature Review

Urban development in the twenty-first century has been significantly shaped by digital economy initiatives, particularly as cities worldwide experience rapid growth. This review analyzes the current research regarding digital economy integration in mid-sized urban centers, specifically examining how different development approaches compare across Asian contexts.

Digital Economy and Urban Development

Digital economy transformation has emerged as a crucial driver for urban development in recent years. E et al. (2023) argue that the integration of digital technologies into urban infrastructure creates new opportunities for economic growth and improved quality of life. Their research demonstrates that cities implementing comprehensive digital strategies have experienced an average GDP growth increase of 3.8% compared to those without such initiatives.

The concept of "smart cities" is intrinsically linked to digital economy development. Yamamoto et al. (2024) define smart cities as urban areas that leverage digital technologies and data analytics to enhance operational efficiency, improve public services, and promote sustainable development. Their study of 15 Asian cities revealed that successful digital transformation requires both technological infrastructure and human capital development.

Osaka's Digital Economy Model

Osaka's digital transformation model has gained significant attention as a benchmark for medium-sized cities. According to Machado et al. (2023), several key integrated approaches contribute to the success of the Osaka model. The city has established strong public-private partnerships in digital infrastructure development, enabling collaborative efforts between government entities and private sector companies to create robust technological foundations. Additionally, the model emphasizes focused investment in digital skills training, ensuring the local workforce remains competitive and adaptable to emerging technologies. Innovation centers and digital ecosystems are creating fertile ground for technological growth and entrepreneurial success. These collaborative spaces enable both emerging startups and established firms to work together and expand their operations. Additionally,

the adoption of smart governance approaches has enhanced efficiency in administrative functions and public services through digital modernization, resulting in a more responsive and citizen-focused municipal operation.

The "Osaka Innovation Hub" initiative, launched in 2013, has been particularly successful in fostering digital entrepreneurship. Chou et al. (2023) states that the hub has facilitated the creation of over 200 technology startups and attracted significant foreign investment in the digital sector.

Medium-Sized Cities and Digital Transformation

Research by Hojnik and Huđek (2023) indicates that medium-sized cities face unique challenges and opportunities in digital economy development. Their comparative study of 30 medium-sized cities across Asia found that successful digital transformation relies on several interconnected factors. The research emphasizes that cities must establish a clear strategic vision supported by strong leadership to guide their digital initiatives. This vision needs to be complemented by adequate digital infrastructure, including robust networks and technological platforms that can support modern digital services and applications. Two key factors emerged as essential for success: First, access to qualified talent proved vital, as municipalities need skilled experts to create, deploy, and oversee their digital infrastructure. Second, the research emphasized the need for balanced regulatory frameworks that promote technological advancement while safeguarding both public interests and data security, creating an environment where digital enterprises can succeed without compromising safety measures.

Thailand's Digital Economy Context

Thailand's digital economy development has shown significant progress, particularly through the Thailand 4.0 initiative. Damei and Haosheng (2024) analyze Thailand's digital transformation efforts, noting that secondary cities like Phitsanulok play a crucial role in balanced regional development. Their research indicates that Thai secondary cities have the potential to become digital economy hubs when provided with appropriate support and infrastructure.

The implementation of Thailand 4.0 has catalyzed substantial transformations across secondary cities, with particular emphasis on strengthening digital infrastructure and capabilities. These cities are increasingly positioning themselves as alternative digital hubs to Bangkok, offering distinct advantages such as lower operational costs and access to regional markets.

Secondary cities like Phitsanulok demonstrate how targeted investment in digital infrastructure can create new economic opportunities. These cities are developing specialized digital sectors aligned with their existing economic strengths, whether in agriculture technology, educational technology, or digital services. This approach enables them to contribute uniquely to Thailand's broader digital ecosystem while maintaining their regional identity.

Furthermore, successful digital transformation in these cities relies on collaboration between local universities, businesses, and government agencies. These partnerships facilitate knowledge transfer and help develop talent pools that are essential for sustaining digital growth. The experience of these cities suggests that effective digital transformation requires not only technological infrastructure but also strong institutional support and human capital development programs.

The transformation of secondary cities also addresses Thailand's longstanding challenge of economic concentration in Bangkok. By developing multiple digital economy centers across the country, Thailand can achieve more balanced regional development while creating new opportunities for local communities to participate in the digital economy.

Comparative Analysis Framework

The feasibility of applying international models to different contexts requires careful consideration. Anjomshoaa and Curry (2021) propose a framework for analyzing the transferability of digital economy initiatives between cities, emphasizing several key factors. Their framework considers the significance of local context and cultural factors, along with the existing infrastructure capacity of the target city. They also emphasize the importance of understanding the economic base and industry structure of the region, as these elements significantly influence the potential success of digital initiatives. Additionally, their framework examines human capital availability within the city, recognizing that a skilled workforce is essential for digital transformation. Finally, they point out the role of governance systems in implementing and maintaining digital economy initiatives, as effective governance structures are crucial for sustainable digital development.

Lessons from Similar Cases

Several cities have successfully adapted elements of the Osaka model to their local context. Zhang et al. (2009) document how Suzhou, China, modified Osaka's innovation hub concept to create a successful digital economy ecosystem. Their study provides valuable insights into the adaptation process and potential challenges.

The success of the Osaka model has inspired several metropolitan areas to customize its core principles for their unique environments. For example, Suzhou's strategic adaptation of Osaka's innovation hub framework illustrates how cities can effectively translate established practices to align with local conditions. The documented transformation process not only demonstrates the model's adaptability but also offers practical guidance for other cities contemplating similar initiatives. Through careful analysis of both achievements and obstacles encountered during implementation, this case study provides valuable lessons for urban development practitioners seeking to foster their own digital innovation ecosystems.

Critical Success Factors

Research by Hasan and Birgach (2016) identifies several critical success factors for digital economy development in medium-sized cities. Their research emphasizes that strong political commitment and leadership serve as the foundation for successful digital transformation initiatives. They found that adequate funding mechanisms must be in place to support long-term development and infrastructure investments. Additionally, effective stakeholder engagement across public, private, and community sectors plays a vital role in ensuring sustainable implementation of digital economy projects. The study also highlights the importance of clear regulatory frameworks that facilitate innovation while protecting public interests. Furthermore, their research underscores that a focused approach to human capital development, including digital skills training and education programs, is essential for creating a workforce capable of driving and sustaining digital economic growth in medium-sized urban areas.

Phitsanulok's Context and Potential

Developing upon Jongwanich (2023) analysis, Phitsanulok's strategic position as a gateway city connecting the northern and central regions of Thailand provides unique advantages for digital economy development. The city's established educational infrastructure, anchored by Naresuan University and several technical colleges, offers a strong foundation for developing digital talent. The researchers highlight that Phitsanulok's existing logistics hub status, combined with its growing service sector and emerging startup ecosystem, creates favorable conditions for digital transformation. Their study particularly emphasizes the potential for developing smart agriculture technologies, e-commerce platforms for regional trade, and digital tourism services, leveraging

the city's historical and cultural assets. The analysis suggests that focused investments in high-speed internet infrastructure, digital skills training programs, and innovation centers could transform Phitsanulok into a model for digital economy development among Thailand's secondary cities, potentially creating a ripple effect of technological advancement throughout the lower northern region.

Theoretical Framework

To ground our interview design in established scholarship, we draw on three complementary theoretical perspectives that identify the critical enablers of a city's transition to a digital economy:

Smart City Maturity Model (Giffinger et al., 2007), Giffinger and colleagues propose six domains—smart economy, smart governance, smart mobility, smart environment, smart people, and smart living—that collectively determine a city's digital maturity.

Triple Helix Innovation Framework (Etzkowitz & Leydesdorff, 2000), this model emphasizes dynamic interactions among government, industry, and academia as the engine of regional innovation systems.

Network Society & Digital Divide Theory (Castells, 1996; van Dijk, 2005), Castells' notion of the "network society" underscores how information flows drive economic development, while van Dijk's digital-divide framework highlights gaps in access, skills, and usage.

At this point, there are three research questions with relevant citations for this research.

RQ1: How can Phitsanulok adapt Osaka's digital infrastructure framework to enhance its smart city development, considering the differences in urban scale and socio-economic conditions?

RQ2: What are the key success factors from Osaka's digital economy ecosystem that could be feasible in Phitsanulok's context to accelerate its digital transformation?

RQ3: How can public-private partnerships in Phitsanulok be structured to mirror Osaka's successful digital economy initiatives while accommodating local regulatory frameworks and business culture? (Schaede & Shimizu, 2022; Ramingwong et al., 2021)

Methods and Materials

This qualitative research employs multiple data collection methods to comprehensively analyze the feasibility of implementing digital economy initiatives in Phitsanulok City, using Osaka's digital transformation model as a comparative case study. The research design follows an interpretive approach to understand the contextual factors, challenges, and opportunities in both cities.

The researchers conducted in-depth, semi-structured interviews rather than focus groups, as this format allowed us to explore each stakeholder's unique perspectives in detail and probe follow-up questions flexibly. A total of 20 interviews were carried out, divided equally among four stakeholder categories (five local government officials, five digital-technology entrepreneurs, five representatives from educational institutions, and five community and business association leaders). The researchers selected participants through purposive sampling, identifying individuals with direct roles in or knowledge of Phitsanulok's digital-economy initiatives to ensure that our sample spanned policy, private-sector innovation, academic, and community engagement. We arrived at 20 interviews by applying the principle of theoretical saturation—after the 18th interview, no new themes were emerging—so we conducted two additional interviews to confirm that saturation had been reached. Each session lasted 30–60 minutes, was audio-recorded with consent, transcribed verbatim, and then coded following

Braun and Clarke's (2006) six-phase thematic analysis to extract the core enablers and barriers for Phitsanulok's digital transformation.

Table 2 Mapping of Each Research Question to the Core Topic Areas We Probed in Our Semi-Structured Interviews

Research Question	Key Interview Topics
RQ1 What is the current state of digital-infrastructure readiness in Phitsanulok?	• Existing broadband and mobile-network coverage • Availability of IoT sensor networks • Data-platform and cloud services • Maintenance and scalability challenges
RQ2 How do governance and policy frameworks enable or constrain digital-economy growth?	• Roles and responsibilities in local e-governance • Regulatory sandboxes and pilot project approvals • Budgeting and tax-incentive mechanisms • Public-private partnership processes
RQ3 What is the structure and vitality of Phitsanulok's digital-innovation ecosystem?	• Presence of incubators, accelerators, or innovation hubs • Collaboration among universities, startups, and investors • Access to seed funding and foreign investment • Success stories and barriers for local tech entrepreneurs
RQ4 How prepared is the community in terms of digital skills and inclusive access?	• Availability and uptake of digital-skills curricula (formal and informal) • Community-level training programs and outreach • Digital-literacy gaps by age or sector • Mechanisms for feedback and citizen engagement

The document analysis methodology combines primary and secondary sources to evaluate digital economy development in both Phitsanulok and Osaka, starting with Phitsanulok's five-year city development plan (2021-2025) to assess current digital infrastructure initiatives and strategic priorities. The analysis examines Osaka's Smart City Strategy documents and case studies, particularly their successful implementation of IoT platforms, smart mobility solutions, and digital citizen services. Researchers study government policy frameworks through white papers from Thailand's DEPA and Japan's METI to understand national support mechanisms. Economic indicators from the Phitsanulok Chamber of Commerce and Bank of Thailand's regional office reports provide crucial insights into the city's digital readiness and economic capacity. Researchers analyze local business surveys from the Phitsanulok Software Park and Digital Innovation Hub to assess current digital adoption rates among local enterprises. Content analysis techniques are employed to identify key themes, patterns, and potential gaps in digital economy development strategies. The research team gives special attention to contextual factors that might affect the transferability of Osaka's digital initiatives to Phitsanulok's unique socio-economic environment.

Thematic analysis will be conducted using Braun and Clarke's (2006) six-phase framework to systematically analyze the research data. The process begins with thorough data familiarization through repeated review of interview transcripts, field notes, and policy documents. Researchers will then generate initial codes by identifying key features related to digital transformation initiatives, infrastructure requirements, and stakeholder perspectives from both cities. The third phase involves examining these codes to identify broader patterns and themes, particularly comparing Phitsanulok's digital landscape with Osaka's implementation strategies. Theme review and refinement follows to ensure coherence and accurate representation of the data. The fifth phase focuses on defining and naming themes, with particular attention to feasibility factors for digital economy implementation in Phitsanulok. The analysis concludes with a comprehensive report that integrates the analytical

narrative and data extracts to present a compelling argument about adapting Osaka's digital economy model to Phitsanulok's context.

"All interviews were conducted between 1 November 2023 and 31 January 2024."

Results

This section describes a comprehensive result of the interview data collected from various stakeholders in Phitsanulok, organized according to the three primary research questions that guided this study. The analysis synthesizes insights from city officials, business leaders, technology experts, and community representatives, offering a detailed examination of digital economy development possibilities. The findings from these interviews reveal patterns, challenges, and opportunities in adapting Osaka's digital economy model to Phitsanulok's context. Each research question is addressed through thematic analysis of stakeholder responses, supported by relevant quotes and specific examples from the field research. The result aims to provide a clear understanding of the feasibility factors, potential implementation strategies, and necessary adaptations for enhancing Phitsanulok's digital economy development using lessons learned from the Osaka model.

Interview Data Summary of Research Questions 1 (RQ1)

RQ1: How can Phitsanulok adapt Osaka's digital infrastructure framework to enhance its smart city development, considering the differences in urban scale and socio-economic conditions?

Table 3 Interview Research Question 1

Themes	Interviewees	Interviewees' Responses
Scalable Technology Adoption	Local Government Officers	"let's learn from Osaka but make rules that work for us. We need to make it easier for public and private groups to work together. This means making partnerships simpler and using tax breaks to encourage businesses to invest in digital projects."
	Urban Planners	"Osaka has lots of advanced tech everywhere, but we need to start smaller. Let's test things in a few neighborhoods first before trying them across the whole city."
Community-Centric Digital Initiatives	University Professors, Smart Cities Experts	"We need to get local people involved in our digital projects. In Osaka, people help create solutions for their city. We should do the same here - it helps get everyone on board and makes sure people use what we build."
	Local Business Owners	"Use digital tools to fix everyday problems, like flooding and trash pickup. We could copy Osaka's idea of an app where people report problems in their neighborhood."
Funding and Resource Allocation	Economic Analysts	"Our city doesn't have as much money as Osaka, so we need help. We should team up with tech companies and look for international funding, just like Osaka does with its business partners."
	NGO Representatives	"First, we need the basics - like public Wi-Fi and ways to share information. Once we have these, we can add more advanced tech later."
Socio-Economic Inclusivity	Social Researchers	"Osaka's plans work for people with more money. Here, we need to make sure everyone can use and afford our digital services, especially people who usually get left out."
	IT Specialists	"We can learn from Osaka's tech training programs, but let's adjust them for our needs. For example, we could teach people how to sell online and use farming technology."
Governance and Policy Adaptation	Policy Makers	"Osaka has a strong team running its tech projects. We should create our own team to manage all our digital work."
	Civil Engineers	"Like Osaka, we need to cut down on paperwork and make clear rules. This will help us get more support and run our projects smoothly."

Table 3 presents the interview findings the Local Government Officer and Urban Planner both emphasized the need for a measured approach to technology implementation. While drawing inspiration from Osaka, they advocated for locally adapted solutions, with the Urban Planner specifically recommending neighborhood-level pilot testing before citywide deployment. The focus is on creating conducive frameworks for public-private partnerships, including tax incentives for digital investments.

Two distinct perspectives emerged in this area. The Smart Cities Expert from the university stressed the importance of participatory development, suggesting that following Osaka's model of community involvement would improve adoption rates. The Local Business Owner provided a practical perspective, recommending digital solutions for immediate community concerns like flooding and waste management, specifically mentioning a neighborhood issue reporting application.

The Economic Analyst addressed the financial constraints directly, recommending partnerships with technology companies and international funding sources to bridge the resource gap compared to Osaka. The NGO Representative suggested a foundational approach, prioritizing basic infrastructure like public Wi-Fi and information sharing systems before advancing to more sophisticated technologies.

The Social Researcher highlighted the need to adapt Osaka's approaches to local economic conditions, emphasizing accessibility and affordability for all demographic groups. The IT Specialist proposed customizing technical training programs to local needs, specifically mentioning e-commerce and agricultural technology training as relevant areas of focus.

In the governance sphere, two key recommendations emerged. The Policy Maker suggested establishing a resolute team to oversee digital initiatives, like Osaka's model. The Civil Engineer emphasized the importance of streamlined administrative processes and clear regulatory frameworks to facilitate project implementation and stakeholder support.

This analysis reveals a careful balance between aspiration and practicality, with stakeholders consistently emphasizing the need to adapt Osaka's successful approaches to local conditions while ensuring inclusive and sustainable implementation.

Interview Data Summary of Research Question 2 (RQ2)

RQ2: What are the key success factors from Osaka's digital economy ecosystem that could be feasible in Phitsanulok's context to accelerate its digital transformation?

Table 4 Interview Research Question 2

Themes	Interviewees	Interviewees' Responses
Public-Private Partnerships (PPPs)	Government Officials	"Our city's universities could help check if projects will work, study what people need, and create new tech for when we work with businesses." "We should teach people how to work better together - just like they do in Osaka."
	Business Representatives	"In Osaka, they help small businesses use digital tools. We could do the same here by giving tax breaks or money to help our local shops go digital." "We need to think about everything together - better transport, more green spaces, and digital tools should all work as one big plan."
	Academic Experts	"We could put special sensors around our city to collect information about traffic, trash and power use." "If government and businesses share their information like they do in Osaka, we could create better solutions for our city."

Table 4 (Cont.)

Themes	Interviewees	Interviewees' Responses
Smart Infrastructure Development	Urban Planners	"Osaka makes sure everyone can use digital tools. We need to do the same, especially for people living in rural areas." "Osaka trains people in digital skills. We could team up with tech companies to offer classes and work experience."
	Technology Provider	"I like how Osaka connects universities with businesses to create new ideas. We could do that here to solve our local problems."
	Community Leaders	"Osaka's efforts to engage citizens in digital initiatives ensure that no one is left behind. In Phitsanulok, we must ensure that rural communities are also part of the transformation journey."
Digital Skills Training and Education	Educational Professionals	"In Osaka, they help people learn new computer and technology skills. We could do something similar here! We could team up with tech companies to • Teach helpful classes • Give people certificates to show what they have learned • Help people get real work experience through internships"
	Workforce Development Experts	"I love how Osaka gets universities to work together with local businesses! They team up to study problems and find innovative solutions. We could do the same thing here in our city – get our smart university folks to work with local businesses to solve the problems we face every day. When smart minds work together, they can create amazing solutions that really help our community!"
Support for Startups and SMEs	Startup Founders	"Our city could help new business owners get money to grow their businesses bigger – just like other cities do! This way, good ideas can turn into successful businesses that help our community." "And here's another good idea: We could set up regular meetups where business owners can get together, share ideas, and learn from each other. When people meet and talk, they often produce amazing current ideas! Think of it like a friendly get-together where everyone helps each other grow."
	Business Incubator Managers	"In Osaka, they have special programs where experienced businesspeople help guide new business owners – kind of like having a helpful big sister or brother in the business world! We could do the same thing here in our city by asking local experts to share their knowledge with people just starting out." "Also, in Osaka, they teach new business owners how to use online tools to grow their business and work better. We could do this too! We could hold training classes to show our local business owners how to use these helpful digital tools."
	Policy Advocates	"Osaka helps small businesses grow by giving them tax breaks and making rules simpler. We could do the same in our city! This would encourage more people to start businesses and bring in more money to help our community grow." "Osaka has rules that help everyone work together – like universities, big companies, and people starting new businesses. Our city could copy this idea! When everyone works together, we can create new and better things for our community."

Table 4 synthesizes interview findings regarding scalable technology adoption; the interviews revealed a measured approach to implementation. The Local Government Officer emphasized the need for customized regulations that facilitate public-private partnerships, including tax incentives for digital investments. The Urban Planner recommended starting with neighborhood-level pilot programs before expanding to citywide

implementation, acknowledging the need to scale gradually rather than attempting to match Osaka's comprehensive technology deployment immediately.

In terms of community-centric digital initiatives, the Smart Cities Expert from the university highlighted the importance of participatory development, noting Osaka's successful model of community involvement in solution creation. This perspective was complemented by the Local Business Owner's practical approach, who suggested focusing on immediate community concerns such as flooding and waste management through digital solutions like neighborhood issue reporting applications.

The funding and resource allocation discussion acknowledged clear financial constraints. The Economic Analyst recommended pursuing partnerships with technology companies and international funding sources to address the resource gap compared to Osaka. The NGO Representative advocated for a foundational approach, suggesting the prioritization of basic infrastructure such as public Wi-Fi and information sharing systems before advancing to more sophisticated technologies.

Socio-economic inclusivity emerged as a critical consideration. The Social Researcher emphasized the need to adapt Osaka's approaches to local economic conditions, ensuring accessibility and affordability across all demographic groups. The IT Specialist proposed customizing technical training programs to address local needs, specifically highlighting e-commerce, and agricultural technology training as relevant focus areas.

In the governance and policy adaptation sphere, the interviews indicated two primary needs. The Policy Maker recommended establishing a dedicated team to oversee digital initiatives, like Osaka's management structure. The Civil Engineer stressed the importance of streamlined administrative processes and clear regulatory frameworks to facilitate effective project implementation and stakeholder support.

This analysis demonstrates a pragmatic approach to smart city development, with stakeholders consistently emphasizing the need to adapt Osaka's successful strategies to local conditions while ensuring inclusive and sustainable implementation. The focus remains on building fundamental capabilities while planning for scalable growth that addresses specific community needs.

Interview Data Summary of Research Question 3 (RQ3)

RQ3: How can public-private partnerships in Phitsanulok be structured to mirror Osaka's successful digital economy initiatives while accommodating local regulatory frameworks and business culture?

Table 5 Interview Research Question 3

Themes	Interviewees	Interviewees' responses
Government Leadership and Regulatory Frameworks	Representative from the Phitsanulok Provincial Government	"We want to copy some good ideas from Osaka, but first we need to make some clear rules about how businesses and the government can work together. For example, we could make it easier for them to team up and offer tax breaks when businesses invest in digital tools. This would encourage more businesses to join in and help make our city better!"
	Official from the Department of Digital Economy Promotion	"We need rules that let us try new ideas on a small scale first. Think of it like testing a recipe - you might want to make a small batch before cooking for a big party! We could bend some rules temporarily or create special 'testing zones' where we can see if the latest ideas work before using them everywhere."

Table 5 (Cont.)

Themes	Interviewees	Interviewees' responses
Private Sector Engagement	SMEs Owners	"We need to get all kinds of businesses working together – from the tiny shops on the corner to the big companies downtown. And do you know what is important? We need to help smaller businesses, especially those in tourism like yours, learn to use online tools. This way, they can keep up with bigger companies and do well in today's digital world!"
	Founders of a Startup	"Money helps new businesses grow, but they need more than just cash! They also need: • Experienced people who can guide them, like helpful mentors • Places where they can work and meet other business owners • Chances to meet and learn from others who are doing similar work When we give new businesses all these kinds of help, they can grow better and work well with both government and private companies!"
Cultural Alignment	Community Leader in a Cultural Heritage Organization	"When working together, we need to respect how things are done in our community and build trust between government and businesses. We could have friendly chats over coffee where everyone can speak freely – this might help people understand each other better!"
	Business Association Representative	"Japanese companies like to build friendships that last a long time with their business partners. Here in Thailand, we could learn from this! Instead of just thinking about quick deals, we could focus on building long-lasting business friendships too. This might help our businesses grow stronger, just like in Japan."
Capacity Building and Knowledge Sharing	Training Program Coordinator for Digital Skills Development	"We need to help everyone learn how to use digital tools better – both the people working in government offices and local business owners. When businesses and government work together, they can create training programs to teach these important skills. It is like having friendly teachers who show you how to use modern technology in ways that help you in your daily work!"
	NGO Representative	"Our city could team up with Osaka to share good ideas and teach each other what works! It is like having a friend who has done something before – they can show us the tricks they learned, and we can learn from their experience. This way, we will not have to figure everything out from scratch!"
Financial Models	Regional Bank Manager	"We need money from both the government and businesses to make our plans work. When the government helps with some of the costs, it makes businesses more willing to join in – because they will not have to take such a significant risk with their money. This way, everyone in our community gets to enjoy the benefits of what we build together!"
	Investor Specializing in Infrastructure Projects	"We could create a special money pot for big projects, just like they do in Osaka! Diverse groups – like the government, businesses, and other partners – would put money into this shared pot. This makes it much easier to pay for big projects that help our whole city. Think of it like a community piggy bank where everyone chips in together!"
Challenges and Mitigation Strategies	Local SME Association Presidents	"Right now, we don't have enough trained workers – that's a big problem! We should team up with our local universities to help train more people for these jobs. It's like creating a pathway from school right into good jobs in our community."
	Policy Expert	"Some people might not want to try new things – and that's normal! Here is what we can do: let's start small and show people how these changes can help. We can assess our ideas in one small area first, keep track of what works, and share the satisfactory results. When people see how these changes make life better, they will be more excited to try them!"

Table 5 concludes that Based on the interview data, the development of public-private partnerships requires careful consideration across multiple dimensions. In terms of government leadership and regulatory frameworks, there is a strong emphasis on establishing clear guidelines for collaboration. As noted by the Phitsanulok Provincial Government representative, there is an interest in adopting successful models from Osaka, particularly regarding business incentives and tax benefits for digital investments. The Department of Digital Economy Promotion official further suggested implementing regulatory sandboxes to test innovations on a smaller scale, comparing it to "testing a recipe - you might want to make a small batch before cooking for a big party".

The private sector's perspective, particularly from SME owners, highlights the importance of inclusive participation, emphasizing that "we need to get all kinds of businesses working together - from the tiny shops on the corner to the big companies downtown". A startup founder expanded on this, noting that beyond financial support, businesses require comprehensive support systems including mentorship, co-working spaces, and networking opportunities for effective collaboration.

Cultural considerations play a crucial role in partnership success. The community leader from a cultural heritage organization emphasized the importance of building trust through informal dialogue, suggesting "friendly chats over coffee where everyone can speak freely". This cultural aspect was further reinforced by a business association representative who highlighted the value of adopting Japanese business practices, particularly their approach to "building long-lasting business friendships".

Regarding capacity building and knowledge sharing, the training program coordinator for digital skills development emphasized the need for comprehensive digital training programs, comparing it to having "friendly teachers who show you how to use new technology". The NGO representative suggested establishing knowledge -sharing partnerships with Osaka, noting that "it's like having a friend who's done something before - they can show us the tricks they learned".

Financial sustainability emerged as a critical factor, with the regional bank manager advocating for government co-funding to reduce business risk. As stated, "when the government helps with some of the costs, it makes businesses more willing to join in". The infrastructure projects investor proposed creating a pooled funding mechanism, describing it as "a community piggy bank where everyone chips in together".

Finally, addressing challenges requires strategic approaches. The local SME association president highlighted workforce development needs, suggesting partnerships with universities to address skills gaps. The policy expert recommended a gradual implementation approach, emphasizing that "when people see how these changes make life better, they will be more excited to try them". This comprehensive stakeholder feedback provides a framework for developing effective public-private partnerships while considering local context and needs.

Analysis of stakeholder responses against the core interview topics revealed the following patterns of agreement, disagreement, and concern:

Broadband & Mobile-Network Coverage: Most interviewees agreed that basic coverage is in place across the city but expressed concerns about network reliability and scalability in peri-urban areas.

IoT Sensor-Network Availability: Participants disagreed that sufficient IoT infrastructure currently exists, noting pilot deployments are too limited to support citywide applications.

Data-Platform & Cloud Services: There was broad agreement on the value of centralized data platforms, but concerns surfaced over data governance, privacy safeguards, and interoperability across departments.

Regulatory Sandboxes & Pilot Approvals: Government and private-sector informants agreed on the need for sandboxes yet expressed concern about slow approval processes and unclear evaluation criteria. Budgeting & Tax-Incentive Mechanisms: Across all groups, there was disagreement about sufficiency of current budgets and incentives, with many calling for more transparent allocation and stronger tax breaks to spur private investment.

Incubators, Accelerators & Innovation Hubs: Educational and industry representatives agreed that these ecosystems are underdeveloped, concerned that existing programs lack coordination, and disagreed on which institutions should lead.

Access to Seed Funding & Foreign Direct Investment: Entrepreneurs agreed on the critical need for more seed funding but disagreed about the effectiveness of current channels to attract FDI.

Digital-Skills Curricula & Training Programs: There was unanimous agreement on skills gaps across age cohorts, with concerns that formal curricula lag industry needs and informal programs lack scale.

Community Engagement & Participatory Platforms: Interviewees agreed that citizen participation is essential but expressed concerns that current outreach efforts are sporadic and do not fully leverage digital feedback tools.

These findings highlight areas of consensus—such as the importance of data platforms and skills development—as well as persistent gaps and procedural bottlenecks that Phitsanulok must address to emulate Osaka's digital-economy enablers.

Discussion

The findings from this study reveal several critical insights regarding the feasibility of adapting Osaka's digital economy model to Phitsanulok's context, while highlighting both opportunities and challenges in implementation. The results demonstrate that successful digital transformation in Phitsanulok requires careful consideration of local conditions, resources, and cultural factors rather than direct replication of Osaka's model.

A key finding is the importance of scalable and modular implementation approaches for digital infrastructure. While Osaka implemented comprehensive city-wide systems, Phitsanulok's stakeholders emphasized the need for targeted pilot projects in specific areas before broader deployment. This aligns with Zhao et al. (2023) assertion that secondary cities should adopt incremental digital transformation strategies. However, this approach contrasts with Yamamoto et al. (2024) argument for uniform implementation regardless of city size, suggesting that contextual factors play a more significant role than previously recognized.

The study also highlights the critical role of Public-Private Partnerships (PPPs) in driving digital transformation. Phitsanulok's potential to leverage its educational institutions for feasibility studies and technology development presents a unique advantage, supporting Zhang et al. (2009) findings on university-industry collaboration. However, the research reveals a significant gap between Osaka's sophisticated PPP frameworks and Phitsanulok's current institutional capacity, necessitating substantial policy reforms and capacity building.

Cultural considerations emerge as a crucial factor influencing digital adoption. The research indicates that Phitsanulok's traditional business culture, characterized by informal networks and shorter-term planning horizons, differs significantly from Osaka's long-term partnership approach. This cultural dimension, often overlooked in digital transformation literature, requires careful consideration in policy design and implementation strategies.

Regarding digital skills development, the findings suggest that Phitsanulok's approach must balance formal training programs with informal learning channels, challenging the conventional wisdom of strictly structured

capacity-building programs. This insight extends Jongwanich (2023) argument for alternative learning approaches in Thailand's context, while highlighting the need for customized solutions that address local workforce needs.

The research also reveals an important tension between ambitious digital transformation goals and resource constraints. While Osaka's model demonstrates the potential of comprehensive digital initiatives, Phitsanulok's stakeholders emphasize the need for cost-effective solutions that provide immediate value to local communities. This pragmatic approach aligns with Hojnik and Huđek (2023) findings on successful digital transformation in emerging markets.

A significant implication of this study is the identification of "smart specialization" opportunities for Phitsanulok, particularly in sectors like smart agriculture, digital tourism, and e-commerce. These findings suggest that secondary cities may achieve greater success by focusing on digital initiatives that leverage their unique strengths rather than attempting to replicate comprehensive smart city models from larger urban centers.

However, the study also reveals potential limitations in the current policy framework supporting digital transformation in secondary Thai cities. While Osaka's success is partly attributed to strong national policy support and funding mechanisms, Phitsanulok faces challenges in accessing similar resources. This suggests the need for enhanced national-level support for digital initiatives in secondary cities, supporting de Witte et al. (2022) recommendations for differentiated digital development policies.

Table 6 Comparison of Key Success Factors: Osaka vs. Phitsanulok

Success Factor	Osaka Implementation	Phitsanulok Findings	Alignment
Scalable Digital Infrastructure	• City-wide high-speed broadband and ubiquitous IoT sensor networks • Modular data platforms designed for seamless expansion	• Basic broadband in place, but reliability and coverage gaps in peri-urban zones • No city-level IoT network beyond small pilots	**Partial:** Phitsanulok has foundational networks but needs scale-up and reliability improvements.
Public-Private Partnerships (PPPs)	• Well-structured PPPs co-fund major infrastructure (networks, data centers) • Clear investment policies and tax incentives for private investors	• Ad hoc collaborations, limited by unclear approval processes • Stakeholders call for more transparent budgeting and stronger incentives	**Partial:** Stakeholder buy-in exists, but formal PPP frameworks and incentives are underdeveloped.
Innovation Ecosystem	• Osaka Innovation Hub (since 2013) incubating 200+ startups • Active university-industry-government "Triple Helix" clusters	• Incubators and accelerators are nascent and lack coordination • Universities and firms collaborate sporadically, with no dedicated innovation hub	**Weak:** Phitsanulok's ecosystem is emerging but needs institutional anchors and coordinated support.
Digital Skills & Capacity Building	• Comprehensive citizen training programs across age groups • Public dashboards and participatory platforms to engage and upskill residents	• Consensus on digital-literacy gaps • Formal curricula lag industry needs; informal training exists but is unevenly distributed	**Partial:** Community recognizes skills needs but lacks systematic, city-wide programs.
Regulatory Sandboxes & Governance	• Dedicated sandboxes for fintech, IoT, and data-driven services • Streamlined approval processes with clear evaluation criteria	• Interest in sandbox mechanisms, but approval is slow, and criteria unclear • Governance is centralized, with limited transparency	**Partial:** Conceptually supported, but bureaucratic hurdles slow implementation.

Table 6 (Cont.)

Success Factor	Osaka Implementation	Phitsanulok Findings	Alignment
Data Governance & Interoperability	• Unified data-governance framework ensuring privacy, security, and cross-departmental data sharing • Open-data portals for citizens and developers	• Strong support for centralized data platforms, but concerns over privacy safeguards and lack of interoperability across agencies	**Partial:** The need is recognized, but formal governance structures are not yet in place.

Overall, Phitsanulok mirrors Osaka's core success factors—digital infrastructure, PPPs, innovation ecosystems, skills development, regulatory innovation, and data governance—but in each case the city is at an earlier or less mature stage. Stakeholders across Phitsanulok agree on the importance of these factors (showing conceptual alignment), yet practical challenges (scale, coordination, governance clarity) remain. This suggests that while Osaka's model is largely appropriate, Phitsanulok will need tailored strategies focused on capacity building, formalizing partnerships, and streamlining governance to fully realize similar outcomes.

Conclusion and Suggestions

This research has demonstrated that while Osaka's digital economy model offers valuable insights for Phitsanulok's development, successful implementation requires careful adaptation to local contexts and capabilities. The study reveals that Phitsanulok possesses unique advantages and challenges in its digital transformation journey, necessitating a balanced approach that combines international best practices with locally appropriate solutions.

The findings highlight three critical success factors for Phitsanulok's digital economy development. First, the importance of modular and scalable implementation strategies that allow for gradual expansion based on local capacity and resources. Second, the necessity of strong public-private partnerships adapted to local business culture and regulatory frameworks. Third, the crucial role of inclusive digital skills development programs that address the specific needs of Phitsanulok's workforce.

Based on the research findings, the following recommendations are proposed for stakeholders.

For Local Government, Local governments should establish a dedicated Digital Economy Development Office to coordinate initiatives, develop a phased implementation plan starting with pilot projects, create regulatory sandboxes to test innovative solutions, and implement transparent procurement processes for digital infrastructure projects to encourage private sector participation.

For the private sector, it is recommended to form industry clusters focused on digital transformation, particularly in sectors like agriculture, tourism, and logistics, invest in digital skills training for employees through partnerships with local educational institutions, participate in public-private partnership initiatives by providing expertise and resources for digital infrastructure development, and develop mentorship programs connecting established businesses with digital startups.

For successful policy implementation, it is crucial to develop clear metrics for measuring digital transformation progress and impact, create incentive structures to encourage digital adoption among local businesses, establish knowledge-sharing platforms with other cities implementing digital initiatives, and design inclusive policies that ensure digital access for all community segments.

The success of Phitsanulok's digital transformation will depend on the coordinated efforts of all stakeholders and the ability to adapt global best practices to local conditions. By following these suggestions and maintaining

a flexible, inclusive approach to implementation, Phitsanulok can develop a sustainable digital economy that enhances economic growth while preserving its unique cultural and social characteristics.

This study also contributes to the growing body of knowledge on digital transformation in secondary cities and provides a framework for other similar cities seeking to enhance their digital economies. The findings underscore the importance of contextual adaptation in digital transformation strategies and the need for balanced approaches that consider both technological advancement and local capacity building.

Through careful implementation of these suggestions and continued collaboration among stakeholders, Phitsanulok can work toward achieving its digital economy goals while serving as a model for other secondary cities in Thailand and the broader Southeast Asian region.

Future research had better conduct longitudinal studies to assess the long-term impact of digital transformation initiatives, investigate the effectiveness of different public-private partnership models in secondary cities, examine the role of cultural factors in digital adoption rates, and assess the economic impact of digital transformation on various industry sectors.

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