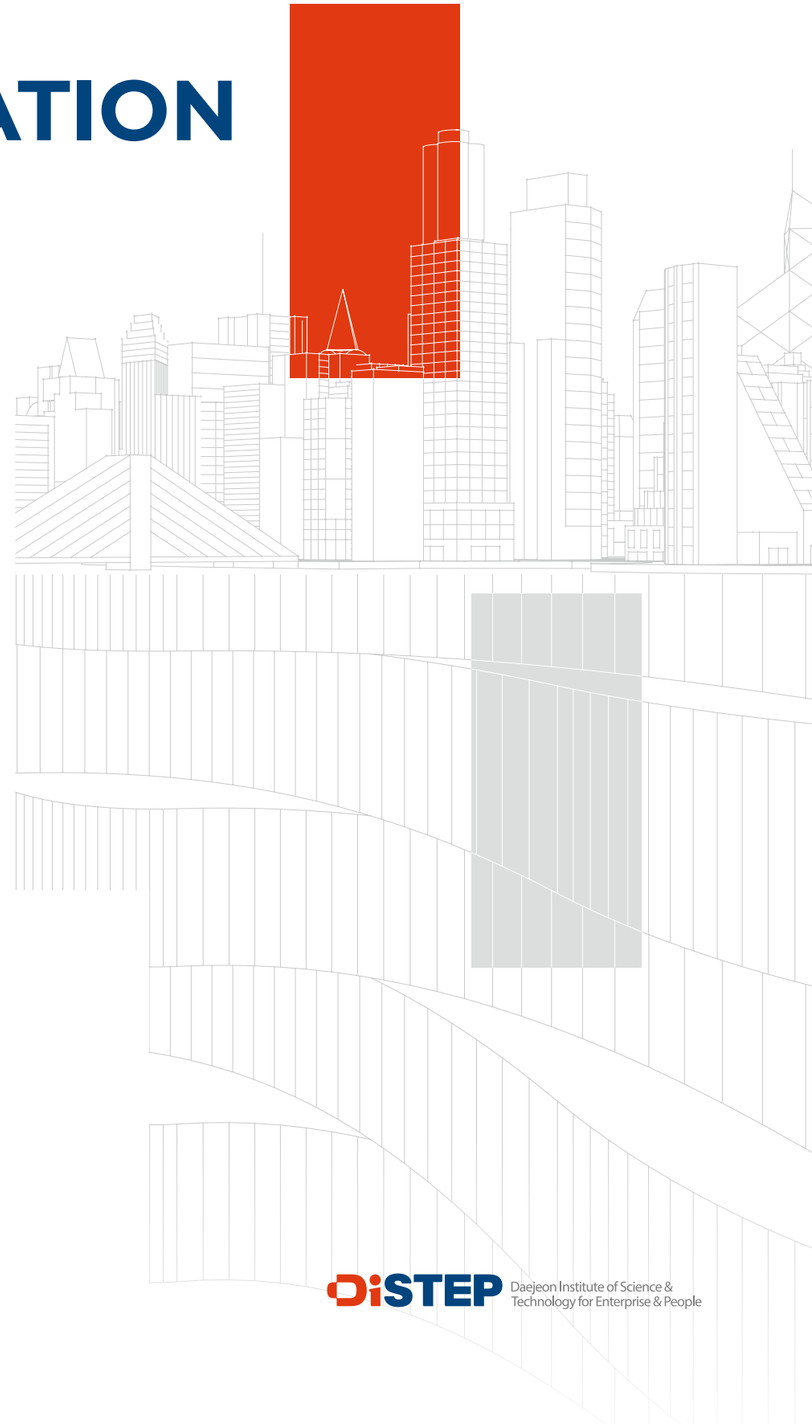
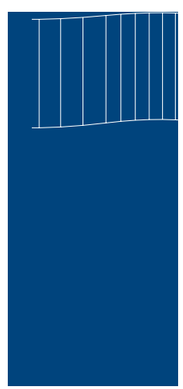
DiSTEP Daejeon Institute of Science & Technology for Enterprise & People

GLOBAL URBAN INNOVATION BRIEF

No. 2





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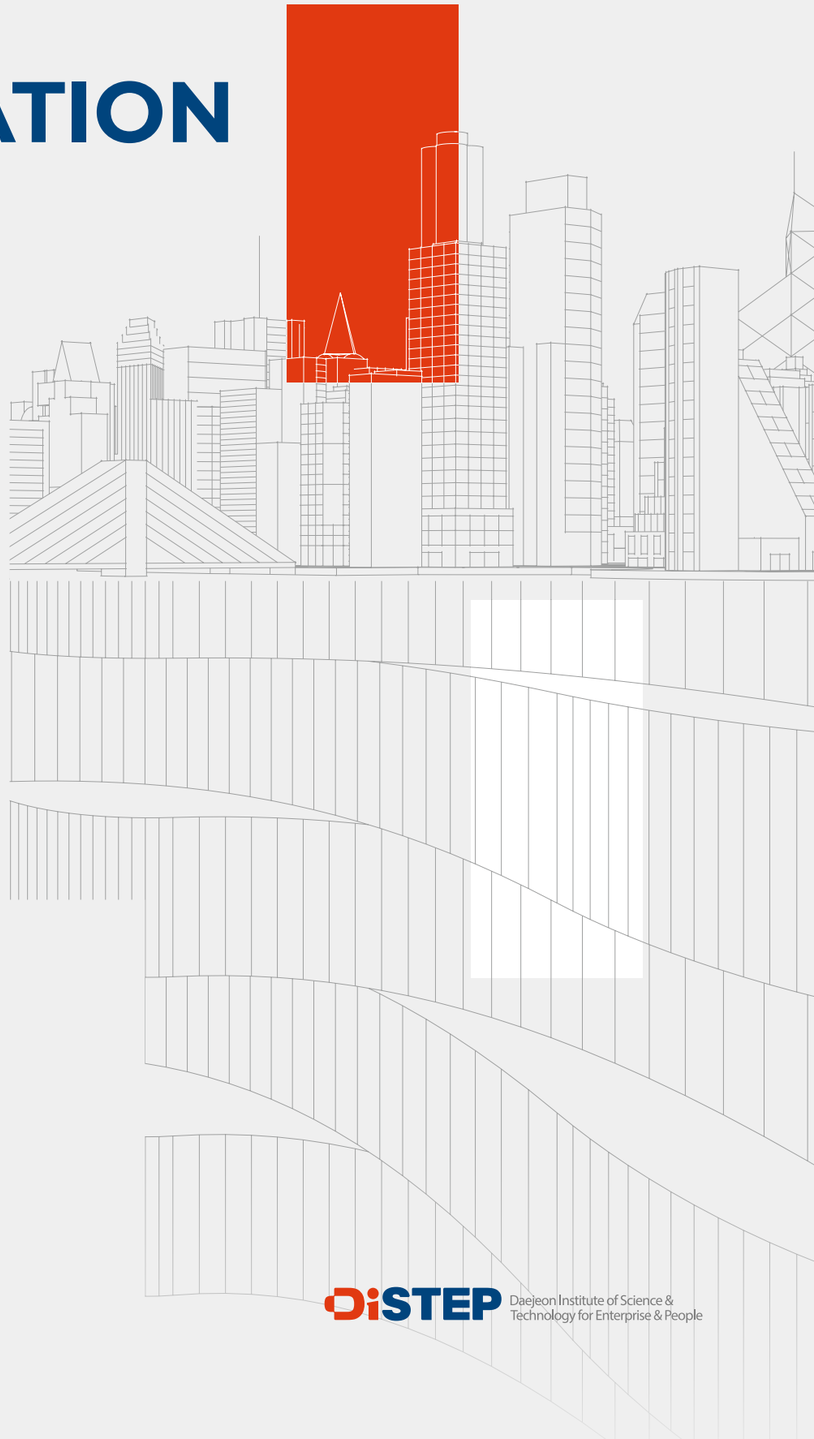
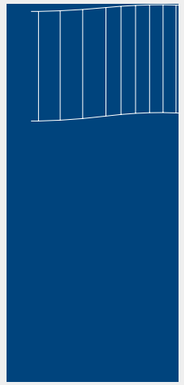
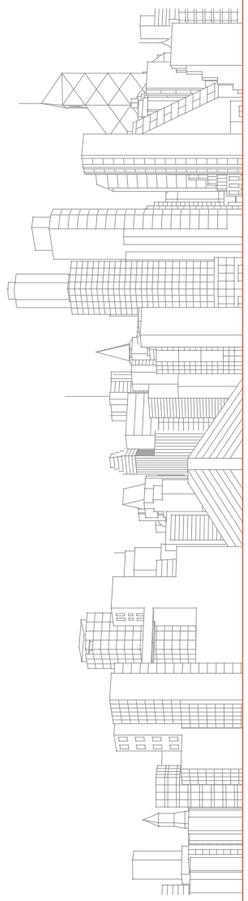




DiSTEP Daejeon Institute of Science & Technology for Enterprise & People

Foreword



The Daejeon Institute of Science & Technology for Enterprise and People (DiSTEP) is a specialized policy organization dedicated to fostering new industries driven by science and technology, advancing regional innovation, and implementing strategies to enhance global competitiveness.

In response to the increasing global emphasis on advanced technologies and industries, Daejeon has prioritized the growth of four strategic sectors—Aerospace, Bio-health, Nano-semiconductors, and Defense—along with two emerging fields: Quantum Technology and Robotics. These initiatives aim to solidify Daejeon's position as a leading hub for science and technology-driven innovation. To support this vision, DiSTEP is harnessing local innovation capabilities and global networks to identify and cultivate sustainable growth opportunities.

This brief highlights case studies from cities around the world that have successfully addressed urban challenges and achieved sustainable development through science, technology, and policy innovation. It is designed to provide foundational insights for researchers and professionals in urban and innovation policy. Furthermore, by fostering knowledge exchange with global experts in urban innovation, we seek to strengthen international collaboration networks and support Daejeon's progress as a leading innovation-driven city.

We hope this brief offers meaningful insights to stakeholders in science and technology-based urban innovation and serves as a catalyst for Daejeon's continued growth and success.

November 2024

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01

The role of innovation communities in shaping urban development

Ebba Lund,
Chief Executive Officer,
IASP(International Association of Science Parks and Areas of Innovation)

Abstract

Regional innovation is essential for economic growth, technological progress, and an improved quality of life, with organised innovation spaces playing a key role in fostering collaboration between stakeholders such as businesses, academia, and governments. The International Association of Science Parks and Areas of Innovation (IASP) supports over 300 members across 76 countries, representing more than 100,000 companies located in Science and Technology Parks (STPs), Innovation Districts (IDs), and other innovation areas. These spaces drive regional economic development, and the IASP Global Survey 2024 shows that most innovation spaces are located in cities, with a significant number in large urban areas. Málaga TechPark in Spain exemplifies the role of these spaces, functioning as a successful public-private collaboration that integrates regional stakeholders to drive innovation and urban development.In collaboration with the University of Málaga, the park fosters innovation and entrepreneurship by facilitating technology transfer from academic research to commercial applications. This partnership has created a robust innovation ecosystem, supported by initiatives like the Office for the Transfer of Research Results (OTRI) and the #eCityMálaga project. The park's focus on sustainability, smart city solutions, and expanding infrastructure underscores its commitment to long-term growth and development. Málaga TechPark serves as a valuable model for other cities, demonstrating how innovation spaces can effectively contribute to regional development by aligning technological advancement with sustainability and urban integration

Keywords

Innovation, Urban, Collaboration, Technology, Community

Regional innovation is a crucial driver of economic growth, technological advancement, and improved quality of life. Organised innovation spaces(Sanz et al., 2023), such as science and technology parks (STPs), innovation districts (IDs), areas of innovation (AOIs) and other organised innovation spaces play a pivotal role in fostering this innovation by creating environments where multiple stakeholders – businesses, research institutions, academia and government entities - collaborate effectively.

The International Association of Science Parks and Areas of Innovation (IASP) supports such innovation spaces throughout the world. With over 300 members in 76 countries, IASP represents a network of more than 100,000 innovation and technology-based companies, from startups and SMEs to large corporates located in these innovation spaces. Data from IASP members consistently show strong positive impacts on regional economies, highlighting the importance of collaboration between organised innovation spaces and their host cities.

IASP's extensive data also provides valuable benchmarks for assessing how science and technology infrastructure can be leveraged in city innovation strategies. The IASP Global Survey 2024 underscores the increasing importance of the urban context, with 89.7% of respondents (AOI, ID, STP members of IASP) being located in a city. Of these, 41.6% are located in a city with more than 1M inhabitants, which means a significant community with whom to interact and engage.

Málaga TechPark, located in Málaga, Spain, exemplifies how innovation spaces can catalyse regional development and integrate with their host cities. It is one of Spain's largest technology hubs, operating as a public-private initiative involving the Regional Government of Andalucía, the City of Málaga, Banco Unicaja, and the University of Málaga. This successful model of collaboration makes Málaga TechPark an ideal case study for exploring the impact of innovation spaces on urban development.

This article explores how Málaga TechPark engages with the City of Málaga and collaborates with the local university to drive regional innovation. By examining this case study as a proof of concept, we highlight how targeted science and

technology initiatives within innovation spaces can solve pressing urban challenges and contribute to broader city innovation strategies. Before delving into this specific case, however, it is essential to understand the broader role of organised innovation spaces like STPs, IDs, and AOIs in urban and regional development.

The role of innovation in economic growth has long been recognised in both literature and policy. Innovation spaces are ideally positioned at the crossroads of these processes, attracting a critical mass of businesses and entrepreneurs. By bringing together researchers, investors, and institutions, they catalyse the transfer of knowledge, fostering collaborative innovation and co-creation. This process materialises into what is commonly known as an innovation ecosystem, where economic growth is driven by the continuous exchange of ideas and expertise.

Innovation spaces integrate with their host cities by creating synergies among local government, academia, and private enterprises. This integration fosters mutual benefits, including economic growth, job creation, and increased global visibility. While part of the same family, there are distinct differences between different types of organised innovation spaces. STPs, managed by full-time teams with significant authority over operations, typically facilitate partnerships between universities, research institutions, and companies. They attract high-tech companies and skilled workers, driving economic growth and enhancing the city's innovation ecosystem.

IDs, embedded within urban areas, combine business, recreational, and residential functions, revitalising urban spaces and attracting talent through collaborative governance involving public and private entities. AOIs, more expansive in scale, create interconnected ecosystems across cities or regions, supporting sustainable development through coordinated efforts among diverse stakeholders.

However, the true value of these spaces extends beyond their physical setting to the services and amenities they offer. They provide services like incubation programs that nurture early-stage startups through mentorship, resources, and business development support, and venture capital access that connects entrepreneurs with funding opportunities essential for scaling their innovations.

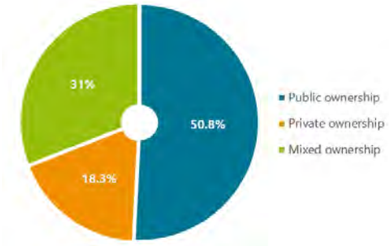
Recognising the importance of this, IASP created an STP performance assessment tool, which is designed to offer users insights as to how and to what extent an STP blends or "fits" within its regional innovation ecosystem (IE), how and where it might be truly adding value to their IE and the nature and extent of the impact it might be having on the economy of its locality or region. The philosophy behind the self-assessment tool is that any STP is set in the context of a national or regional IE. Therefore, its performance should be measured by how well it "fits" with or complements other actors in the ecosystem in building a more vibrant and supportive system for innovators and their companies. The types of contribution STPs can make are generally known and are largely complementary to the contribution of universities and other actors in the innovation ecosystem.

Málaga TechPark provides a concrete example of how STPs contribute to regional innovation and urban growth. Next, we will explore the specific strategies and impacts of Málaga TechPark in fostering development in its region.

Malaga TechPark, also known as Parque Tecnológico de Andalucía (PTA), was established in 1992 and has since grown into one of Europe's largest concentrations of technology companies. The park's development has been driven by a public-private initiative involving the Regional Government of Andalucia, the City of Malaga, Spanish bank Unicaja, and the University of Malaga.

IASP data (2024) reveals that public ownership is the most common ownership model at a global level, followed by mixed ownership (Public-Private-Partnership model) and the city (local government) one of the key public actors promoting our industry.

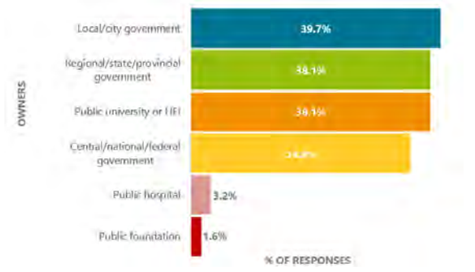
Figure 1. OWNERSHIP OF AOIs/IDs/STPs



Source: IASP (2024)

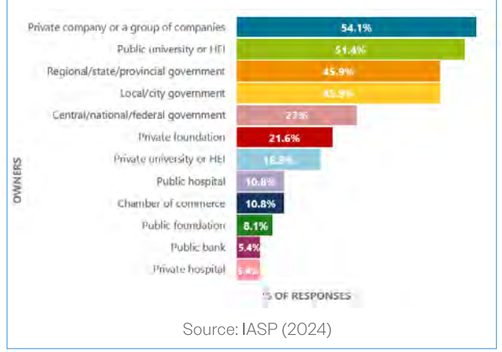
In the case of solely public ownership 39.7% of AOIs/IDs/STPs having local/city government as an owner, and mixed ownership the city is one of the owners for 45.9% of AOIs/IDs/STPs.

Figure 2. PUBLIC OWNERSHIP OF AOIs/IDs/STPs



Source: IASP (2024)

Figure 3. MIXED OWNERSHIP OF AOIs/IDs/STPs



Source: IASP (2024)

Over the years, Malaga TechPark has expanded to cover over 2 million square metres dedicated to innovation. The park boasts a diverse industry presence, including Information and Communication Technology (ICT), biotechnology, energy, electronics, aerospace, and digital services. Companies like Oracle, Ericsson, Accenture, and Vodafone have established significant operations within the park. The ICT sector is particularly strong, with over 15,000 professionals working in this field, making up close to 55% of the total number of employees in the park working in ICT. This concentration has solidified Malaga TechPark's reputation as a leading technological hub in Spain.

Malaga, the sixth largest city in Spain, has a metropolitan population of approximately 1.2 million people, including 253,000 foreign residents from over 140 nationalities. Malaga TechPark collaborates closely with the City of Malaga on several initiatives aimed at enhancing urban development and fostering innovation. The park is also involved in developing smart city solutions with the local government, focusing on advanced technologies in transportation, energy management, and public services. These initiatives demonstrate Malaga TechPark's commitment to improving quality of life while driving economic growth.

To further integrate its activities within the city, Malaga TechPark has established four strategic enclaves across Malaga(Malaga TechPark, 2024):

- **The Green Ray by PTA-UMA:** Located within the University of Málaga's extended campus, this enclave serves as a hub for entrepreneurial activity and innovation, blending the resources of Malaga TechPark with fresh talent from the university to support startups and new projects.
- **Puerto de Málaga – Málaga TechPark:** This collaboration with the Málaga Port Authority and Fundación MálagaPort focuses on joint R&D projects, leveraging the port's potential as a regional economic driver through technological innovation.
- **Fundación Unicaja – Málaga TechPark:** This enclave supports startups and business projects with social impact, offering a new coworking space in the city centre, at Centro Cultural Fundación Unicaja de Málaga.
- **Teatro del Soho CaixaBank – Málaga TechPark:** Linking cultural and business sectors, this initiative

promotes interaction between technological enterprises and the arts, providing a platform for cultural startups within Malaga TechPark's ecosystem.

These enclaves reflect Malaga TechPark's deep integration with the city's infrastructure and cultural landscape, enhancing its role as a key driver of economic and technological growth in the region.

The local government is actively involved in the governance of Malaga TechPark, with representatives from the City of Malaga and the Junta de Andalucía (regional government) serving on the park's board of directors. This involvement ensures that the park's development aligns with regional economic goals and secures public support for various initiatives, further embedding the park within the city's strategic framework.

The park's role as a hub for technological innovation is further supported by its strategic location, just 13 kilometres from Malaga's city centre and 12 kilometres from the International Malaga-Costa del Sol Airport. This location provides easy access to transportation hubs, facilitating business operations. The diverse workforce, with over 21 nationalities represented among the 25,101 professionals, contributes to a rich, collaborative environment that fosters innovation across various sectors.

One of the most significant collaborations at Malaga TechPark is with the University of Malaga (UMA), which plays a pivotal role in fostering innovation and entrepreneurship. This partnership has facilitated the transfer of technology from academic research to commercial applications, helping bridge the gap between theory and practice.

The University of Malaga is not only a major source of qualified talent but also an active participant in the park's innovation ecosystem. With over 40,000 students and 20 faculties, UMA is a hub of young and dynamic talent, particularly in Information and Production Technologies. This talent pool is directly integrated into Malaga TechPark's activities, with nearly 150 students annually participating in internships across various fields such as software development, data analysis, cybersecurity, and artificial intelligence. These internships often lead to full-time employment, underscoring the strong alignment between academic training and industry needs.

Role of technology transfer in facilitating innovation

A cornerstone of UMA's collaboration with Malaga TechPark is the Office for the Transfer of Research Results (OTRI), which plays a crucial role in transforming academic research into market-ready innovations. Established within the park, OTRI acts as a bridge between UMA's research community and the industry, ensuring that innovative ideas and research findings are efficiently transferred to companies within the park. This office not only supports the commercialisation of research but also actively identifies market needs and aligns university research projects with these needs, thereby enhancing the relevance and impact of academic work.

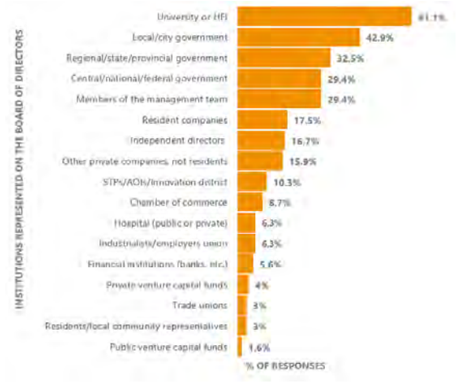
This proximity allows OTRI to provide more tailored support, such as advising on intellectual property, facilitating partnerships, and managing spin-off ventures. OTRI's involvement has been instrumental in the success of various research initiatives and the establishment of startups within The Green Ray, a hub dedicated to fostering entrepreneurship within the university community.

In addition to this, the office of innovation and technological cooperation, UMAinnTECH, has recently had a strategic relocation to Malaga TechPark's headquarters which further strengthens this collaboration, facilitating even closer interaction between researchers and industry professionals. This office was born with the fundamental objective of creating new opportunities for innovation with the environment of Malaga TechPark. At the same time it aims to act as an axis in the transversal cooperation of the Malaga TechPark with the different services and centres of the UMA.

Through these collaborative efforts, Malaga TechPark and UMA have created a thriving environment where academic research seamlessly transitions into commercial ventures, driving economic growth and the development of a highly skilled workforce.

The IASP Global Survey 2024 shows that for 36.5% of AOIs/IDs/STPs around the world collaboration with the city is a very important factor of success while for 40.5% it is a moderately important factor. Their involvement is key to activities with 42.9% having city government representatives on their Boards of Directors.

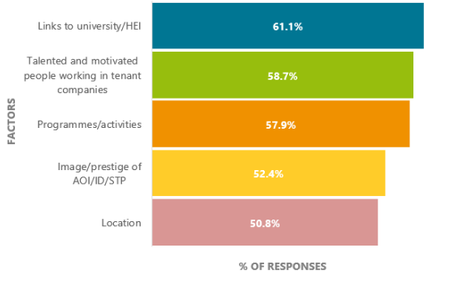
Figure 4. REPRESENTATIVES ON AOI/ID/ STP BOARDS OF DIRECTORS



Source: IASP (2024)

The factors which are most key are talented and motivated people working in resident companies as well as the image and prestige of the AOI/ID/STP, with 58.7% and 52.4% of respondents viewing these factors as "very important" respectively.

Figure 5. REPRESENTATIVES ON AOI/ID/ STP BOARDS OF DIRECTORS



Source: IASP (2024)

Today, Malaga TechPark is home to 687 companies and 25,101 professionals, significantly contributing to the local economy. The park has attracted over €900 million in investment, with 80% coming from private sources, highlighting its financial robustness and appeal to investors. The park's activities account for over 20% of Málaga's GDP, underscoring its importance to the region's economic landscape.

Additionally, the park emphasises sustainability, featuring 900,000 square metres of green spaces that align with broader goals of sustainable urban development. The pioneering #eCityMálaga project is currently being tested in Málaga TechPark (PTA), a smart city model that aims to boost innovation in renewable energies, sustainable transport, efficient construction and digital infrastructures, becoming a benchmark for the "circular economy" model, in which the use of resources, waste generation and energy consumption are minimised by reducing material cycles. This will be extended to the rest of the city in 2027.

Malaga TechPark is not only a significant contributor to the local economy but is also poised for future growth. The park is actively expanding, with plans for over 115,000 square metres of new construction, including office spaces and production areas, reflecting its ongoing commitment to providing cutting-edge facilities. The success of Malaga TechPark is further evidenced by its ability to attract substantial investments in innovation, as demonstrated by the establishment of the Ricardo Valle Institute of Innovation (Innova IRV). Focused on microelectronics, cybersecurity, AI, and advanced communications, Innova IRV has positioned Malaga TechPark as a leader in cutting-edge research. The planned expansion of the park, including new facilities and sustainable transport options, reaffirms its commitment to growth and innovation.

In conclusion, organised innovation spaces play a pivotal role in driving regional innovation by fostering a dynamic ecosystem that bridges the gap between research, industry, and technology. What has been seen with the collaboration between the park and the city of Malaga highlights the importance of aligning urban development with sustainable practices, ensuring that technological growth is both inclusive and environmentally responsible.

For policymakers and other innovation spaces, Malaga Tech Park serves as a valuable model, offering lessons in the importance of strong partnerships with local governments,

the need for sustainability in innovation, and the benefits of community engagement. These insights can guide other urban areas and STPs in creating thriving, future-ready environments.

Moving forward, it is essential to encourage further research and collaboration between such communities and their host cities. The integration is crucial for achieving mutual benefits, such as job creation, sustainable urban development, and enhanced innovation capacity. By continuing to explore and refine these partnerships, even greater potential for innovation, economic growth, and sustainability on a global scale can be unlocked.

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- IASP Global Survey 2024 (report in preparation)
- Malaga 2030 strategic plan
- Malaga TechPark: Strategic Enclaves

02

Journey from Brain Drain and Brain Gain to Brain Circulation: Bengaluru, India as a Start-up Entrepreneurial Ecosystem to Address Global Problems

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Abstract

Bengaluru's rise to prominence as a premier entrepreneurial ecosystem for technology start-ups has attracted considerable interest from the wider world. This report identifies the factors that have shaped Bengaluru's transition into an environment that is conducive to start-ups. The study seeks to pinpoint the pivotal forces responsible for this shift by analyzing the distinct combination of cultural, economic, and infrastructural elements (Brain Drain, Brain Gain, and Brain Circulation). The key initiatives supporting Bengaluru's entrepreneurial ecosystem are also highlighted. Special emphasis on growth of Returnee Entrepreneurs is also put forward. Through a thorough investigation of products and services developed by the Returnees, the impact of innovation for solving global problems that has transformed 'Bengaluru' into a brand as a key participant in the global technology start-up landscape is suggested.

Keywords

IT and Start-up Capital,
Returnee Entrepreneurs,
Viksit Bharat,
Start-up Hub

Bengaluru is the capital of Karnataka state, which is situated in the southern part of India. According to the 2011 Census, the city's population was approximately 8.4 million, but estimates in 2021 suggest it has grown to over 12 million, making it the third most populous city in India. The cosmopolitan city is also known as the 'IT and Start-up Capital' of India, as depicted in Figure 1.

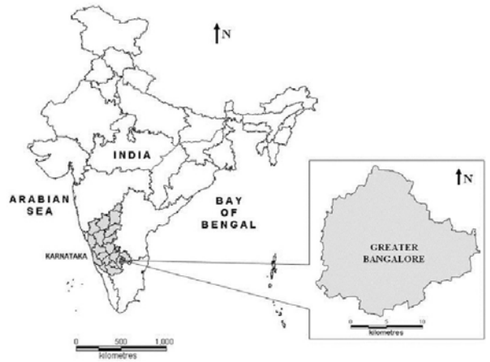

Figure 1. Bengaluru as the IT and Start-up Hub

The city hosts the headquarters of major global and Indian technology companies like Infosys, Wipro, Flipkart etc. The IT sector alone contributes significantly to both the city's and the state's GDP. Considering the larger entrepreneurial ecosystem, Bengaluru is also known as the 'Silicon Valley of India' due to its dense concentration of technology companies, start-ups, and venture capital firms. Bengaluru's thriving entrepreneurial ecosystem has risen to prominence on a global scale as a hub for technology start-ups and a platform for budding entrepreneurs. In particular, the city is blessed with pleasant weather, which is one of the abundant natural support systems to co-evolve the entrepreneurial ecosystem along with becoming an IT hub in India. Certainly, Bengaluru holds a distinct position as the primary hub for start-ups in India by consistently drawing attention from all over the globe.

India faced a 'brain drain' during 1960s to 1980s, through which the highly skilled workforce started migrating to OECD Countries. Due to the economic reforms in late 90s and early part of the 21st century, these skilled workers eventually started returning to India due to improved and more equivalent employment opportunities through the presence of multinational companies in India, resulting in a 'brain gain'. On the personnel front, the children of the returning migrant workforce started reaching the adolescent stage in parallel. This situation also motivated these skilled workers return to their home country to begin a new career either through intrapreneurship or entrepreneurship. In the current scenario, there are growing evidence that these skilled workers started widely returning to India . Due to the diaspora created in the host countries, these returnees started moving across various countries--a phenomenon which is known as as 'brain circulation'--resulting in social mobility. This elite class of entrepreneurs have come to be known as 'Returnee Entrepreneurs (REs)'. In particular, the new professional lives of these Returnees are being seen in start-ups, which can then address local, as well as global, problems at large. As per a 2023 report from The Economist, 6.41% of migrants around the globe are Indians, and there is an opportunity for these migrants to return to Bengaluru's entrepreneurial ecosystem for the purpose of establishing start-ups.

As per the latest World Bank report, India is looking to overcome the 'middle-class syndrome' by increasing the per capita income of every individual. Moreover, India is one among the 108 middle income countries that is aspiring for exponential growth to cherish the objectives of Vision Viksit Bharat @ 2047, which would then allow India to achieve the status of a developed nation. Thus, there is a need for India, and particularly Bengaluru, to examine South Korea's model to march towards high income status. During 1960s and 1970s, South Korea began sending qualified individuals from large companies to visit OECD nations as a form of 'investment' into personnel as a resource and their larger companies. Along with providing financial support, the government encouraged these qualified individuals to bring ideas back to Korea from the rest of the world, resulting in a knowledge 'infusion'. As competitors from the global market started increasing the trade license fee, the Korean conglomerates valued 'innovation' as the path forward. In summary, the high-income status of South Korea has been attained through 'Investment, Infusion, and Innovation', more popularly known as '3I Model', as per the World Bank report.

To contribute towards disruptive growth, Bengaluru has realized that a conducive entrepreneurial ecosystem to nurture start-ups for the global economy is both warranted and deemed a present need. Entrepreneurship and entrepreneurs play vital roles in propelling economic growth due to their contributions towards generating job opportunities, fostering innovation, stimulating competition, and increasing market competitiveness (Eisenmann, 2020). The start-up ecosystem in Bengaluru is vibrant and hosts numerous start-up events, incubators, accelerators, and co-working spaces (Bala Subrahmanya, 2017) that provide networking opportunities, exposure to investors, and access to resources for start-ups. The city is home to several renowned incubators and accelerators which provide mentorship, funding, and support services to start-ups at various stages of growth (Malage & Navi, 2023). Bengaluru attracts a significant portion of venture capital investment in India and has a strong presence in the country. In 2020 alone, over $10 billion was invested in local businesses, outpacing investments in more well-known cities such as San Francisco and London. Additionally, angel investors and crowdfunding platforms contribute to the funding landscape for start-ups (Grant Thornton, 2016).

Bengaluru, being the epicentre of the start-up ecosystem in Karnataka, boasts a large pool of tech talent, including engineers, developers, and designers. This talent pool fuels innovation and drives the growth of start-ups in the region. The start-up ecosystem spans across various sectors including information technology, biotechnology, healthcare, fintech, agritech, and e-commerce. Start-ups in these sectors benefit from the state's strong industrial base and access to domain expertise (Han et al., 2021). Overall, Bengaluru's start-up ecosystem is characterized by innovation, collaboration, and a supportive environment for entrepreneurs. With its conducive ecosystem and robust infrastructure, the state continues to attract start-ups and investors from across the globe (Korreck, 2019). Moreover, the pillar of India's technology ecosystem, National Association of Software and Service Companies (NASSCOM), is headquartered in Bengaluru.

The start-up ecosystem is particularly well-positioned to address global problems using innovative solutions. Start-ups in the city are leveraging cutting-edge technologies like artificial intelligence, blockchain, and biotechnology to tackle challenges such as:

- **Healthcare:** Start-ups like Practo and Portea are revolutionizing healthcare delivery, making it accessible and affordable, not just in India but globally.
- **Climate Change:** Companies like ReNew Power and Ather Energy are developing sustainable energy solutions, contributing to global efforts in combating climate change.
- **Education:** EdTech companies like BYJU's are transforming education by providing personalized learning experiences, thus, addressing the global challenge of educational inequality.
- **Fintech:** Start-ups such as Razorpay and Zerodha are creating inclusive financial services and helping to address issues related to financial access and literacy worldwide.

The start-up ecosystem in Bengaluru has grown enormously in recent years and the city is a major force behind advancement and economic development. A few of the science and technology initiatives supporting Bengaluru's entrepreneurial ecosystem include:

Table 1. Initiatives Supporting Bengaluru's Entrepreneurial Ecosystem

- Karnataka Information Technology Policy: 2020-2025
- Karnataka Innovation and Technology Society (KITS)
- Bengaluru Urban Observatory
- Bengaluru Mobility Innovation Lab
- Clean Bengaluru Initiative
- Institute of Bioinformatics and Applied Biotechnology (IBAB)

- Karnataka Start-up Policy: 2022-2027
- Karnataka Digital Economy Mission
- Centre for Cellular and Molecular Platforms (C-CAMP)
- Bangalore Bio-innovation Centre (BBC)
- Indihood: Bengaluru's Groundbreaking Community-Driven Digital Ecosystem
- Co-Working Policy: Fostering Innovation and Collaboration

total unicorns (start-ups valued at over $1 billion) in India. The city has a thriving ecosystem that continues to produce high-growth companies across various sectors, as reported in Table 2. These unicorns have significantly strengthened Bengaluru's reputation as a leading hub for start-ups through economic growth by attracting substantial venture capital and private equity investments. Thereby boosting the local economy (Brail, 2020). Unicorns have created thousands of direct and ancillary jobs across various functions (Lehmann et al., 2019).

Table 2. List of Unicorns from Bengaluru

Company	Sector	Launch Year
Rapido	Mobile App (Taxi Booking - Bikes)	Jul-24
Perfios	Fintech -Credit Assessment	Mar-24
Krutrim	Conversational AI	Jan-24
Leadsquared	SaaS - CRM	Jun-22
Open Financial Technologies	Fintech - Neo Bank	May-22
Amagi Media Labs	SaaS - Local Ads Targeting	Mar-22
Hasura	SaaS - Programming Tools	Feb-22
LivSpace	Interior Design - Modular Kitchens & Home Products	Feb-22
Polygon	Web3 Infrastructure - DApps	Feb-22
Slice	Fintech - Credit Cards	Nov-21
NoBroker	Proptech - Classifieds	Nov-21
Mensa Brands	Aggregator - Consumer Brands	Nov-21
Cult. fit	Healthtech - Wellness	Nov-21
Acko	Fintech - General Insurance	Oct-21
CoinSwitch	Cryptocurrency Exchange	Oct-21
Licious	D2C - Meat	Oct-21
Vedantu	Edtech	Sep-21
Apna. co	Marketplace - Jobs	Sep-21
Mobile Premier League	Gaming	Sep-21
Zetwerk	Marketplace - Manufacturing Services	Aug-21
MindTickle	SaaS - HR - Training	Aug-21
BlackBuck	Logistics Services	Jul-21
Zeta	Fintech - API - Banking Products	May-21
ShareChat	Social Media	Apr-21
Groww	Fintech - Brokerage & Mutual Funds	Apr-21
CRED	Fintech - Payments & Credit Card Rewards	Apr-21
Meesho	E-Commerce - Social Commerce	Apr-21
Digit	Fintech - General Insurance	Jan-21
Glance InMobi	Content - Lockscreen	Dec-20
Dailyhunt	Content - News	Dec-20
PhonePe^	Fintech - Payments	Dec-20
Razorpay	Fintech - Payment Gateway	Oct-20
Unacademy	Edtech	Sep-20
Postman	SaaS - API Development & Testing	Jun-20
Ola Electric	Mobility - Electric	Jul-19
BigBasket	E-Commerce - Groceries	Mar-19
Udaan	B2B E-Commerce	Sep-18
Swiggy	Foodtech	Jun-18
BYJUS	Edtech	Jan-18
Quikr*	Marketplace - Classifieds	Apr-15
Ola Cabs	Mobility - Ride Aggregator	Mar-15
Mu Sigma	SaaS - Analytics	Feb-13
Flipkart	E-Commerce	Feb-12
InMobi	Adtech - Mobile Ads	Sep-11

There has also been a drastic improvement in the infrastructural development in Bengaluru due to these developments (Tripathi & Singh, 2021). Unicorns, especially those in Bengaluru, have promoted a culture of innovation and entrepreneurship, inspiring new start-ups and creating a vibrant start-up ecosystem by often sharing their expertise and experience through mentorship, partnerships, and industry-wide events (Kotha et al., 2022). Bengaluru's entrepreneurial ecosystem, with its extensive and equitable strategic interventions, is keen to retain the top spot through conducive funding, incubation, infrastructure, mentoring, acceleration, R&D, and industry linkages in the future as well.

In parallel, there is a new diaspora of REs in Bengaluru with start-ups, which are contributing to the entrepreneurial ecosystem along with domestic entrepreneurs, focusing on global problems. By complementing and supplementing each other (domestic and returnee entrepreneurs alike), Bengaluru can be elevated to a more efficient frontier with the accompanying high-income status. By emulating disruptive growth, other cities within and outside the state can replicate the same growth model across India in the future. In general, entrepreneurs (both domestic and returnees) have less fear of failure, and these elite classes of people are willing to take risks to solve global problems.

In particular, there is a growing trend of REs in Bengaluru wherein their products and/or services are innovative and globally relevant due to continuous visits between their home and host countries. This brain circulation of REs has provided access to modern technologies, social mobility, knowledge capital, and financial resources due to the diaspora created in their host countries. Moreover, China's government has evolved a proactive policy to attract returnees from OECD countries. Even though there is no specific distinction between domestic workers and these Returnees in the governmental policies of India, a study led by Prof. M.H. Bala Subrahmanya at IISc is delving deeply into the specific characteristics of domestic entrepreneurs and REs based on the emergence, stability, and sustenance of tech start-ups through semi-structured interviews. Certainly, the presence of Res, along with domestic entrepreneurs, can co-create synergies leading to the economic development of emerging economies like India and Bengaluru. Moreover, REs have a competitive edge in terms of knowledge and managerial and entrepreneurial skills, which is adding value to the vibrant entrepreneurial ecosystem of Bengaluru (Bala Subrahmanya, 2021). The REs are exposed to global trade and cross-market integration, enabling them to exploit entrepreneurial opportunities which are 'new to the world' across the globe. The following section highlights the success stories of REs from the technology and life science domain, which has created an impact and scale through investment, infusion, and innovation for the purpose of serving the global market through sustainability and competitiveness.

Success Story-1: Anicca Data Science Solutions

The vision of Anicca Data Science Solutions is to focus on providing big data services and building algorithmic products for efficiency improvements in the processes of the data driven world. The key Unique Selling Proposition() of the domain neutral start-up includes aligning data platforms with AI/ML solutions for addressing numerous modern day business challenges. Though the start-up is headquartered in the USA, the Research and Development (R&D) wing is being established at Bengaluru for attainment of competitiveness. One of the co-founderspossesses a zeal for making career advancement though he started with humble beginnings as an Academician (2006 to 2007). Later, he shifted to the corporate world and obtained exposure abroad in the knowledge service domain pertaining to campaign response, fraudulent models etc. in the San Francisco bay area of the USA (2007 to 2018). To balance between personal and professional responsibility, he shifted to Bengaluru in 2019 as the head of the R&D wing to focus on business portfolio aspects like Robotics, Supply Chain Management, LMS, and Edge Computing. All of these advancements were possible due to the risk-taking appetite of the RE, and the start-up is currently situated in three locations which are equipped to serve companies across the globe through co-creation and co-development (source: www.aniccadata.com).

Success Story-2: Anabio

Anabio was founded in 2017 in a garage in Hartford, Connecticut, USA, and later relocated to Bengaluru in 2018. The start-up focuses on wellness, as well as sustainable development in the consumer goods and life science sectors. The start-up's expertise is in the area of innovation, product the development and upscaling of products commonly used in healthcare. The USP of the start-up is to develop and launch "new to the world" products, which include:

- Lab in a Box
- Antiviral and Antimicrobial Efficacy
- Flushable Sanitary Pads

The founding CEO, who is also a RE, completed his postgraduate studies in the USA and spent 13 years abroad (USA and EU) working in corporate sectors. Due to a desire for autonomy and a thirst to pursue innovation by building networks, he started thinking about a start-up to solve global issues. Shifting to Bengaluru for personal reasons in 2018, he spent six years on R&D to develop one product which would have the potential to reach the entire globe. The RE succeeded in attaining support from Bengaluru's entrepreneurial ecosystem like IIM-Bangalore, BBC, as well as support from government schemes like Elevate Grant – 2019, BIRAC, etc. Today, the start-up employs more than 50 employees and is currently aiming to solve global healthcare related problems for health and safety today as well as tomorrow. (source: Anabio Tech)

Conclusions

Bengaluru's entrepreneurial ecosystem is a dynamic and thriving landscape characterized by a confluence of talent, funding, supportive policies, and a culture of innovation. The city's rich history in technology and its evolution as a global start-up hub underpin its significance in the global start-up community with the presence of 40% of the country's unicorns. As Bengaluru continues to nurture and support start-ups across various sectors, it stands as a beacon of entrepreneurship and innovation, driving economic growth and shaping the future of technology and business. The start-up ecosystem for both domestic entrepreneurs and REs plays a pivotal role in the achievement of competitiveness and sustainability. In particular, generating employment opportunities, encouraging innovation, and drawing investment are just a few benefits of REs. Overall, the established start-ups and successful unicorns create ripple effects that lead to the growth of allied industries in the value chain and diversification of the economy. Bengaluru's longstanding history as an incubator of technological progress, combined with its supportive infrastructure, makes it the ideal location for ambitious entrepreneurs looking to start businesses of their own. The start-up ecosystem supplemented by the brain circulation of REs has become an engine of economic progress, which contributes to global trade and cross-market integration.

In summary, in creating a strong infrastructure and a supportive policy environment, the government hopes to ensure that Bengaluru maintains its top spot for start-ups and encourages other developing cities in the country to adhere to Vision Viksit Bharat.

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03

A Synergy of Technology and Nature to Fight Against Climate Change: The Case of 'Garden Terminal' of Bangalore International Airport Limited

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Abstract

This paper discusses the implications of technology collaborating with nature to battle against the rising threat of erratic climatic changes, which has been primarily caused due to the short-sightedness of human activities. Every human accomplishment would be meaningless if we failed to address the pressing environmental issues. The unpredictable climatic conditions in modern times are undeniably the most important challenge for urbanized cities. This study thus sets out to identify and present one of the most sustainable and environmentally friendly human endeavours that is also supportive of the modern needs of society. This case presents the recently constructed Terminal Two, also called as the 'Garden Terminal', of Bangalore International Airport Limited (BIAL). The Garden Terminal effectively showcases the integration of technology and nature to minimize the negative environmental impacts associated with business activities. This paper also highlights BIAL's key pillars of sustainability propelled by technological leadership as one of its guiding principles; these pillars make BIAL a one-of-a-kind airport globally.

Keywords

Sustainability,
Eco-Conscious Infrastructure,
Climate Change

Introduction

The unpredictability of climate conditions, if not addressed in time, will pose a threat to the existence of life on our planet. The adverse effects of human activity are strongly evident in the rising sea levels and melting glaciers. Forests have been destroyed and non-renewable sources of energy have been depleting at ever-faster paces, all to fulfil never ending modern societal needs. In such a situation, it is indeed a delight for any passerby to witness nature shaking hands with infrastructural modernity at Terminal Two of BIAL.

Bengaluru International Airport is a pioneer among airports in Asia regarding sustainability (internationalairportreview.com). Sprawling across 255,000 square metres, the Garden Terminal has been recognised as the largest terminal in the world to be pre-certified with a Platinum LEED rating by USGBC (US Green Building Council) (ACI). Having experienced a growth at a rate far higher than planners had expected, BIAL continues to manage a huge mass of travellers daily. Massive foot traffic inevitably has led to high congestion, huge consumption of energy, and an enormous rise in the overall carbon footprint, all of which are detrimental to our ecosystem. Thus, while airports are one of the major drivers for economic development, it is a well-known fact that large infrastructure is also responsible for 79 percent of all greenhouse gas emissions (according to a recent report published by UNOPS, UNEP, and the University of Oxford). The integration of technology with the remarkable biophilic infrastructure of BIAL is emerging as an effective solution to such challenges. Through this paper, we intend to emphasize the need to harness the positive aspects of technology to tackle the overpowering urban challenge of changing climate.

Climate Shift in Bangalore

Bangalore earned the nickname "Garden City" because of its abundant greenery and numerous public parks. However, an increase in urbanization with Bangalore becoming the Silicon City of India has come with a cost. Primarily, the heavy increase in urbanization has caused tremendous

shifts in the climatic conditions of Bangalore. The amount of urbanized land in Bengaluru has increased by 15% from 2003 to 2018 (Sussman et al., 2019), which in turn has led to higher surface and air temperatures, creating what is known as an Urban Heat Island (UHI) effect. The impact on the changing temperatures of the city is also illustrated in Figure. 1.

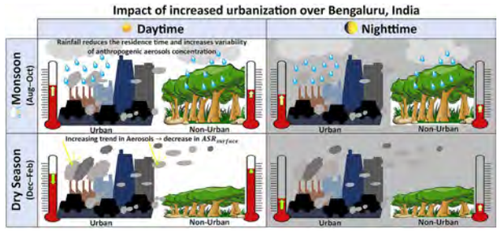

Figure 1. Urbanization and Environmental Effects

Source: Sussman et al. (2019)

Additionally, increased urbanization reduces vegetation density, which further amplifies the UHI effect (Peng et al., 2012; Zhou et al., 2004, 2007). Sussman et al. (2019) emphasize that if cities maintain or augment vegetation and green spaces, the UHI effect will diminish, and the deteriorating air quality will improve. Thus, with its intensive biophilic design supported by technology, the Garden Terminal at BIAL is a pioneering model that sets a high standard and inspires the creation of more eco-friendly and sustainable infrastructure projects.

Eco-Conscious Infrastructure

As per Sridhar L., head of Environmental, Social, & Governance (ESG) efforts at BIAL, climate change risk mitigation is a core element of BIAL's Business Continuity Management policy. This is reflected in the infrastructure of BIAL that innovatively demonstrates the concept of a 'Terminal in a Garden', more than just a 'Garden in a Terminal', which speaks volumes of BIAL's endeavour toward environmental responsibility. Very strategically, prior to beginning construction efforts, up to 6-8" of topsoil, which is comprised of essential microbes, was scraped, stored, and reintroduced in the garden terminal. This topsoil is mercilessly discarded in most other man-made construction projects, and this topsoil is vital for effective carbon management, water conservation, erosion control, and the overall health of our ecosystem. Another notable feature of the garden terminal is its remarkable biodiversity, which includes trees that are between 600 and 800 years old, as well as over 180 rare, endangered, and threatened species indigenous to India. Overall, the terminal's ecosystem supports more than 1,200 tree species. Further, it has 923 kilometres of bamboo cladding that is fire-resistant and has 150,000 live plants hanging from its ceiling alone. The terminal has 10,235 square meters of green walls, 1,200+ trees species and 600,000 live plants that together convert it into an enormous, lush, verdant landscape. Beyond these visible features, the terminal employs technology through extensive solar sharing and intelligent building systems. The indoor plants and outdoor gardens are designed to only require the water that is collected on-site (thehindu.com). In the absence of such an innovation, the airport would have merely been another addition to the man-made 'concrete jungle'. Figure 2 presents the green spaces of BIAL.

Figure 2. Glimpses of Garden Terminal

Source: Ar. Ekansh Goel © Studio Recall

Integration of Sustainability and Technology

The garden terminal employs numerous sophisticated sustainable innovations, including extensive solar shading and intelligent building systems that include engineered, fire-retardant bamboo. Further, it is designed to capture, treat, and reuse rainwater from across the airport. The Airport also employs Building Information Modelling (BIM) for end-to-end project delivery of the entirety of Terminal 2 that further helps in seamless integration with digital facilities management. BIAL is also one of the first airports to be built on a software defined network, effectively automating the ICT network equipment deployment and management with built-in security features (ACI).

Industry.AI has implemented its vision AI platform throughout the Garden. This deployment represents one of the first large-scale implementations of intelligent video analytics at an Indian airport. By using vision AI, the Garden Terminal is able to seamlessly handle issues of congestion and other operational and safety situations at the airport.

The sustainability initiatives, supported by technology, are represented in Figure 3.

Figure 3. Key Sustainability Initiatives Supported by Technology at BIAL

Source: Forbesindia.com

Water Management

Having switched almost entirely to renewable energy sources, BIAL went from being water-depleted to water-positive and energy-neutral (Turner International India), while utilizing state-of-the-art technology for efficient water conservation. The Garden Terminal used Internet of Things (IoT) technology to provide real-time data collection and automated control, a necessary feature for precision irrigation (Netcon). A weather-based smart automatic irrigation system manages the 100-acre landscape at BIAL, utilizing a smartphone app to control its operations. This pioneering system calculates evapotranspiration, soil moisture, and weather conditions to optimize plant irrigation. By integrating a hydro-pneumatic pump station and automatic filtration unit, the system conserves 30% more water compared to traditional methods.

Energy Efficiency

The gardens and forested areas help purify the air, while solar panels and daylight harvesting technologies contribute to approximately 25% in energy savings for the terminal. 90% of the terminal's roof is covered with solar panels (Turner International India). The use of LED lighting, energy-efficient HVAC systems, and advanced building management systems helps in reducing overall energy consumption. Green roofs and walls provide insulation, which lower heating and cooling costs. The greenery also reduces the need for artificial cooling, leading to higher energy efficiency.

Environment Management

The pro-environmental strategies of no plastic, pollution control (which includes air quality management and noise pollution mitigation), waste management, sewage plant treatment (modern sewage treatment technologies ensure that wastewater is treated to high standards before being released or reused, minimizing environmental impact), and solid waste management have enabled the successful sustainability initiative.

Waste Management

Effective management of waste is primarily achieved through functional waste segregation, improving recycling rates and reducing landfill use, and on-site sewage treatment plants that process wastewater to be reused for non-potable purposes like landscaping. This, in turn, reduces the demand for fresh water. Further, strategies to minimize waste generation and divert solid waste from landfills through recycling, composting, and waste-to-energy processes help in managing solid waste as well.

Ecological Management

BIAL is the only airport in the world which holds 3,600 species, including almost 200 endangered species, which are

part of the Indian ecosystem, native to 26 agro-climatic zones of India (Airport World). Planting native species has helped in conserving local flora and reducing maintenance needs.

Impact

BIAL demonstrates a strong commitment towards fighting against the largest evils of urbanization, that undeniably represent the combined negative environmental impact of business activities. Pioneering as the greenest airport in the world, and supported by technology, BIAL has managed to meet major, environmentally-friendly goals by minimizing its dependency on non-renewable resources, 'reusing, reducing, and recycling', harnessing the renewable sources of energy to cover for modern human needs, and minimizing the enormous emissions of greenhouse gases that large infrastructure projects such as airports primarily cause. BIAL has thus achieved net energy neutrality and has significantly lowered carbon emissions. All of this has been achieved through the integration of technology and sustainability.

Conclusion

As urbanization progresses, natural vegetation and forests are increasingly replaced by concrete structures, leading to a complete separation of cities from nature. This shift has resulted in increased pollution, higher temperatures, and greater energy consumption in urban areas. Therefore, it is crucial to focus on preserving and expanding green spaces by integrating green concepts into urban development. Today, BIAL not only boasts of one of the widest varieties of plant life in one location, but also helps to conserve many rare, endangered, and threatened species (Airport World). Sustainable development targets are met by BIAL's environmental strategy, which employs state-of-the-art technology, new services, and innovative ideas. These approaches are widely supported and can be replicated as effective solutions for reintroducing greenery into our increasingly urbanized cities.

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04

Kaohsiung's Path Towards a Dual-Axis Smart City Transformation

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Abstract

Kaohsiung is undergoing a dual-axis transformation focused on digitalization and achieving net-zero emissions. Historically a heavy industry hub, the city now faces significant environmental challenges, particularly as the largest carbon-emitting city in Taiwan. To address this, Kaohsiung is leveraging advanced technologies like AI, IoT, and 5G to drive industrial and urban transformation. Key policies introduced by the Kaohsiung City Government aim to promote industrial transformation by attracting tech companies and fostering innovation clusters. Key initiatives include the Asia New Bay Area Smart Technology Innovation Park, a 5G and AIoT application testing ground. The city is also shifting towards high-tech industries such as semiconductors, smart manufacturing, and AIoT while incorporating sustainable urban policies.

Key insights from the transformation include integrating digital and green strategies for industrial growth and sustainability. However, Kaohsiung's challenges remain, including scaling these innovations for broader industry use and ensuring digital inclusivity for all citizens. Additionally, maintaining resilience in the face of global challenges, such as climate change, will be critical for long-term success.

Keywords

Asia New Bay Area Smart,
Smart city,
Digital transformation,
Net-zero emissions,
Industrial innovation

1. About Kaohsiung

Kaohsiung City is strategically positioned as a transportation hub in the Asia-Pacific region. It is Taiwan's second-largest city by population and uniquely functions as both an international airport and seaport city. Kaohsiung, home to Taiwan's largest port, leverages its geographical advantages to absorb global production resources and access international markets efficiently. In recent years, the city has actively aligned itself with global movements toward net-zero carbon emissions and sustainable development (Kaohsiung City Industrial Development & Investment Promotion Committee, 2024).

- The administrative area of Kaohsiung covers 2,952 square kilometers, with a population of 2,737,941. In 2023, the city's labor force amounted to 1.403 million, while the non-labor force stood at 984,000, resulting in a labor force participation rate of 58.8% and an unemployment rate of 3.40% (Ministry of Labor, 2024).
- The number of registered businesses in Kaohsiung in 2023 was 189,786, with total sales reaching NT$ 5.57656 trillion. Among these, the primary sector (agriculture, forestry, fishery, and animal husbandry) accounted for 0.28%, the secondary sector (manufacturing and production) made up 53.55%, and the tertiary sector (commerce and services) constituted 44.17% (Ministry of Finance,2024).
- In 2023, there were 991 registered foreign and overseas Chinese investment companies in Kaohsiung, with a total capital of NT$ 33 billion, averaging NT$ 33.34 million per company. The manufacturing industry had the most registrations, with 252 companies, accounting for 25.43% (Economic Development Bureau, 2024).

1.1 Why city transformation?

In the 1970s, Kaohsiung developed an industrial stronghold image dominated by heavy industries such as shipbuilding, steel production, and petrochemicals. However, by the 1980s, these industries began facing challenges, such as aging equipment in industries like steel and electricity, environmental pollution from the soil, water, and air contaminants, increasing public health and safety risks from industrial accidents. In 2023, Kaohsiung's gross domestic product was nearly NT$ 6 trillion, with the industrial sector accounting for 53.55%. However, behind this high output lies significant environmental costs, with Kaohsiung responsible for one-fifth of Taiwan's carbon emissions (Environmental Protection Bureau, 2024). As the largest carbon-emitting city in Taiwan, Kaohsiung faces immense pressure to reduce its carbon footprint. Thus, the issue of carbon reduction has become an opportunity for the city's transformation, with "green transformation" emerging as a key focus.

Beyond the need for comprehensive environmental management to safeguard the health and safety of its residents, Kaohsiung must undergo an industrial transformation, starting with pollution control at the source to improve the city's physical infrastructure. Building on the foundation of its past development as an export processing zone and surrounding industrial parks, the Kaohsiung City Government has attracted major tech companies to revitalize its industries. In addition, the digital transformation of existing industries, enabled by technology, aims to reshape the city's appearance. In 2020, the Kaohsiung City Government introduced four priority policies: accelerating industrial transformation, increasing employment opportunities, enhancing transportation infrastructure, and improving air quality. These policies encourage technological innovation, promote industrial transformation, and foster industry-academia collaboration, with the goal of realizing "industrial transformation" and driving "urban transformation." Digital transformation is critical to achieving a sustainable city.

Kaohsiung is also a waterfront city, characterized by mountains, seas, rivers, and harbors. Historically, the city's policies have focused on heavy industries, overlooking its unique landscapes and features. Urban transformation should harness these local characteristics and industrial advantages, preserving the distinctive port-city image. A continual effort to advance "harbor transformation" aims to shape Kaohsiung into a metropolitan waterfront city, exemplified by developments such as the Pier-2 Art Center, KW2, and the Dagang Bridge Complex, as well as the Love River Bay Marina and aquatic recreation parks. Additionally, Kaohsiung is committed to developing the Asia Bay 2.0 Smart Technology Innovation Zone, attracting flagship clusters of emerging technology industries. The integration of the old and new elements within the city seeks to create a harbor economy with a distinct "Kaohsiung flavor," allowing the city to shed its industrial past and achieve the four primary goals of "industrial innovation, livable environment, human-centered welfare, and city safety."

1.2 What is a Sustainable Smart City?

As urban populations grow, cities are confronted with increasingly complex demands and challenges. In a rapidly digitizing world, people have come to expect convenience and real-time information. To meet these expectations, cities must evolve into smart cities, which integrate advanced innovative technologies (combining AI, cloud computing, IoT, and other digital solutions) into the urban infrastructure (water, electricity, roads, bridges, traffic signals, public transportation, etc.) to foster sustainable development in the economic, social, environmental, and cultural spheres. Boyd Cohen's widely adopted "Smart City Wheel" (2012) framework categorizes smart cities into six dimensions: smart economy, smart environment, smart governance, smart living, smart mobility, and smart citizens (Cohen, 2012).

However, building a resilient and sustainable smart city requires more than just green and digital transformation. The most crucial element of a smart city is the integration of the People, Public, and Private sectors, often referred to as the 3P model. Citizens must first generate demand, followed by governmental regulatory guidance and infrastructure development, and finally, private enterprises must participate to create viable business models. The interplay between these three elements forms an ecosystem that can truly achieve sustainable urban development.

1.3 Key Industries and Cluster Industry in Kaohsiung

Michael Porter's research highlights that industrial

competitiveness is not solely determined by an individual sector but also by related and supporting industries. Kaohsiung, a city that initially developed around heavy industry, has become a critical cluster for petrochemical and metal industries in Taiwan, playing a crucial role in supporting Taiwan's economy and bearing the burden of heavy industrial development. The Kaohsiung City Government has leveraged its existing heavy industrial foundation, along with the Southern Taiwan S Corridor's industrial clusters, to actively promote dual-axis transformations in both digitalization and net-zero initiatives. Consequently, Kaohsiung has transformed its industrial environment from traditional, pollution-heavy sectors to high-tech, smart manufacturing industries, continuously attracting high-tech enterprises and talent, both domestic and international. As of 2022, Kaohsiung ranked first in Taiwan in terms of the number and area of industrial park developments(Qu et al., 2022).

Kaohsiung is home to two science parks under the jurisdiction of the National Science and Technology Council: the Kaohsiung (Luzhu) Science Park, covering 567 hectares and focusing on optoelectronics, medical devices, and aerospace industries, and the Ciaotou Science Park, spanning 262 hectares, focusing on semiconductors, smart machinery, and AIoT technologies. Additionally, under the Industrial Development Bureau of the Ministry of Economic Affairs, Kaohsiung hosts eight Technology Industrial Parks (formerly export processing zones) and seven industrial parks. In recent years, additional parks have been approved, including the 58-hectare Asia New Bay Area Smart Technology Innovation Park, serving as a startup base and innovation testing ground; the Nanzih Industrial Park, with 183 hectares, is designated for advanced semiconductor processes (TSMC's planned factory is located here); the Hefa Industrial Park with 136.13 hectares; the Circular Industrial Park (currently under development); and the Renwu Industrial Park with 74 hectares, focusing on low-energy, low-pollution manufacturing.

Key industrial clusters in Kaohsiung include:

1. Petrochemical Industry: Kaohsiung is a central hub for Taiwan's petrochemical industry, with concentrations in Daliao, Renwu, and Linyuan, primarily driven by CPC Corporation. The primary industries include petroleum and coal manufacturing, chemical material manufacturing, chemical product manufacturing, raw material chemicals, rubber products, and plastic products.

2. Metal Industry (Processing, Fasteners, Molds, Aerospace): Kaohsiung is a key center for Taiwan's metal industry, led by China Steel, fostering an industrial cluster that includes basic metal manufacturing and fabricated metal products. The aerospace industry is an essential high-value development direction within the metal sector, with a cluster of aerospace component manufacturers emerging in the Renwu Industrial Park.

3. Marine and Shipbuilding Industry (Yachts): Kaohsiung's shipbuilding industry comprises 117 companies specializing in building container ships, bulk carriers, tankers, naval vessels, and onshore engineering projects, representing over 40% of Taiwan's shipbuilding industry. Additionally, Kaohsiung is Asia's largest yacht manufacturing base, with 17 of Taiwan's 33 yacht manufacturers located in the city, accounting for 80% of Taiwan's total yacht production value. In 2023, the value of Taiwan's yacht industry continued to rise, reaching NT$6.8 billion, with an annual growth rate of 1.6%.

4. International Logistics Industry: Kaohsiung benefits from its comprehensive port and airport logistics infrastructure, making it a critical industrial hub in southern Taiwan. It is one of the few cities in Taiwan with the advantage of both a seaport and an airport, offering incentives such as exemptions from customs duties, commodity taxes, and business taxes, as well as relaxed foreign labor employment ratios.

5. Semiconductor and Optoelectronics Industry: Kaohsiung hosts Taiwan's second-largest semiconductor cluster. The city's various technology parks and the Southern Taiwan Science Park in Kaohsiung have developed into complete semiconductor and optoelectronics clusters with a robust environment for high-tech industrial development. Kaohsiung's strategic location, with access to sea and air ports, enhances its competitiveness in the upstream, midstream, and downstream segments of the semiconductor industry. The city has actively attracted global semiconductor leaders like TSMC, along with related industry players across the value chain, from IC design firms such as Phison Electronics Corp. and Elan Microelectronics to IC manufacturing companies like TSMC and Win Semiconductors and packaging firms like ASE. To further establish Kaohsiung as a significant semiconductor hub, the city government has integrated its existing material and petrochemical industry clusters with the Nanzih Industrial Park (formerly CPC Kaohsiung Refinery) as the core for semiconductor material research and development, creating a new technology cluster. This new semiconductor corridor extends northward to connect with Southern Taiwan Science Park (STSP) and Luzhu and Ciaotou Science Parks, and southward to link with the petrochemical and semiconductor material clusters in Daliao, Renwu, Dashe, Linyuan, and Xiaogang, solidifying the S-shaped semiconductor corridor. This transformation has allowed Kaohsiung to evolve from a heavy industry city into a high-tech smart city (Straits Exchange Foundation, 2022), creating at least 45,000 jobs and attracting over NT$500 billion in investment (refer to Figure 1).

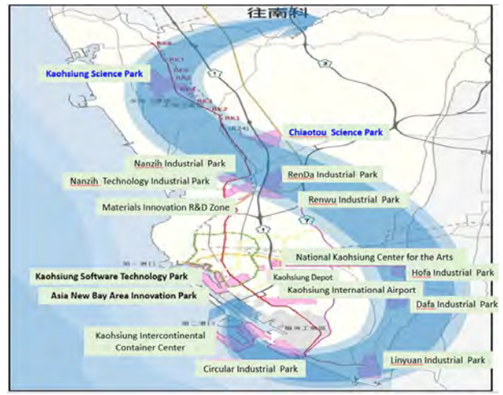

Figure 1. Southern Semiconductor "S Corridor"

Source: Urban Development Bureau, Kaohsiung City Government

2. Asia New Bay Area Smart Technology Innovation Park: A Testing Ground for Smart Innovation

In addition to constructing the semiconductor industry chain, the central government has aimed to balance regional development across northern and southern Taiwan by establishing the "Asia New Bay Area 5G AIoT Innovation Park" in Kaohsiung in 2021. Over the next five years, the central and Kaohsiung governments will jointly invest nearly NT$10 billion in developing the park, smart infrastructure, startup linkages, field applications, talent cultivation, and industry clustering. The goal is positioning the Asia New Bay Area as a premier testing ground for 5G smart infrastructure and networks, encouraging more companies to join the 5G AIoT industry cluster. Large companies such as CPC, Taipower, and China Steel are expected to play a leading role in promoting various innovative applications, including land, sea, and air unmanned vehicles, enhancing Kaohsiung's industrial and marine city characteristics. By linking upstream manufacturing, midstream 5G AIoT, and downstream innovative applications, the park aims to build a comprehensive intelligent technology industry chain and ecosystem, concretely implementing smart city applications in transportation, healthcare, and industrial transformation (Common Wealth Magazine, 2022).

In 2023, the Executive Yuan upgraded the park to "Asia New Bay Area 2.0 Smart Technology Innovation Park " (Figure 2). Initially slated for NT$10.6 billion over five years, the plan was expanded to NT$17.039 billion over seven years, with four key areas of expansion: land, clustering, innovation, and export. The project will extend 5G AIoT innovative applications from testing to commercial validation and expand into fields such as semiconductor IC design, fintech, intelligent audiovisual platforms, smart petrochemicals, and smart port industries. Collaborating with upstream and downstream supply chain partners, the park will establish an international R&D training base, scale up commercial validation solutions, and export them to overseas markets (Kaohsiung Smart City, 2024). The "Asia New Bay Area 2.0" plan is expected to attract NT$55 billion in investment, generate NT$220 billion in output, incubate at least 200 startups, create 4,200 jobs, and bring in international companies to establish R&D centers for innovative applications, positioning Kaohsiung as a critical international base for 5G innovation and driving the city's overall smart industrial transformation (Invest Kaohsiung, 2023a).

Figure 2. Asia New Bay Area (2.0)

Source: Kaohsiung Smart City website (2024)
https://smartcity.kcg.gov.tw/cp.aspx?n=EEB992074926D321

3. Kaohsiung Smart City: Comprehensive Initiatives

The development of a smart city must be human-centric, with a primary focus on meeting the needs of its residents. Constructing a smart city involves integrating next-generation sensing technologies, wired/wireless networks, mobile networks, the Internet of Things (IoT), cloud computing, and decision-making optimization tools into the city's infrastructure. This transformation enables a new generation of intelligent infrastructures highlighting the interrelations between various urban domains and subsystems (Doran & Daniel, 2014). The process is especially crucial for supporting data collection, processing, and sharing (Ishida, 2002; Komninos, 2008), allowing insights to drive improvements that eliminate inefficiencies across city systems and maximize the city's operational effectiveness. In dynamic and complex urban environments, the hallmark of intelligence is the ability to accurately and effectively respond to and solve urban challenges.

The smart city framework encompasses various intelligent applications and services. The primary goal of a smart city is to address critical issues or pain points in citizens' lives through innovative systems, ICT technologies, and process designs. In Kaohsiung, the government's smart city initiatives are not only anchored in the Asia New Bay Area Innovation Technology Park's 5G and AIoT infrastructure but also deeply connected to the city's competitive industrial advantages. The three core strategies for Kaohsiung's smart city development are: (1) citizen-focused, (2) industry-driven, and (3) internationally scalable. Over recent years, the Kaohsiung City Government has implemented more than 50 digital technology applications across domains such as smart transportation, healthcare, agriculture, energy, communities, and governance to address daily urban challenges practically (Invest Kaohsiung, 2023b).

Examples include:

1) Smart Petrochemical Work Zones (March 2024)

As a hub for the petrochemical industry, Kaohsiung has prioritized factory safety. The Ministry of Economic Affairs, through the Asia Bay 2.0 initiative, is leading efforts to integrate AI and IoT technologies into Kaohsiung's petrochemical industry, creating safer operational environments (Invest Kaohsiung, 2024a).

2) Kaohsiung AIoT Sustainable Innovation R&D Center (June 2024)

3) The Kaohsiung City Government has partnered with global cybersecurity and networking leader Cisco, along with system integration giant GENESIS TECHNOLOGY INC., to launch the "Cisco Taiwan Digital Acceleration 3.0" initiative. This collaboration has established the "AIoT Sustainable Innovation R&D Center" in the Asia Bay Area of Kaohsiung, bringing together over 20 ecosystem partners. By integrating AI and IoT, the center aims to enhance the operational efficiency and security of Kaohsiung Port, while simultaneously reducing electricity consumption, energy costs, and carbon emissions. Together, these efforts are transforming Kaohsiung Port into a world-class smart port ecosystem. The initiative also seeks to deepen future collaborations with Kaohsiung in AI, transportation, cybersecurity, and smart city development (Invest Kaohsiung, 2024b).

4) Taipei-1 AI Supercomputer Advanced Computing Center (June 2024)

The largest AI supercomputer center in Taiwan was established in Kaohsiung. In response to the AI trend, Foxconn partnered with NVIDIA to set up the "Taipei-1 AI Supercomputer Advanced Computility Center" in the Kaohsiung Software Park, aimed at developing various domains, including AI, electric vehicles, smart factories, robotics, and smart cities. This initiative will also engage ecosystem partners to promote the practical implementation of generative AI applications. Currently, Foxconn has assisted the Kaohsiung City Government in the adoption of smart public transportation management, with future plans to introduce generative AI technologies in digital governance and healthcare.

5) Mobility as a Service (MaaS)

Kaohsiung was the first city in Asia to implement a MaaS system, offering comprehensive smart transport solutions. The city's intelligent transportation system leverages open data to enhance livability, providing real-time solutions during significant events such as concerts by international artists (such as Backstreet Boys, Westlife, BLACKPINK, Coldplay). The system efficiently manages real-time data on crowds, traffic, rainfall, and hotel occupancy, using visual analytics and predictive technologies to ensure smooth operations. This enables the efficient evacuation of up to 200,000 concertgoers within an hour(CIO Taiwan, 2024).

6) CityGPT Ecosystem

The Kaohsiung City Government and Foxconn jointly developed the "CityGPT Ecosystem," leveraging MODEL T electric vehicles as IoT carriers to collect citywide data. This data is shared across a smart city platform, connecting services such as smart transportation and tourism, creating a cohesive urban network(Invest Kaohsiung, 2024c; Foxconn website, 2023).

7) Federated Learning Platform for AI-Powered Healthcare

In 2020, Kaohsiung launched the world's first federated learning platform, FedGPT, integrating medical data from various institutions to accelerate AI applications in healthcare. By 2024, 80% of Taiwan's medical centers had joined Kaohsiung's smart healthcare network, providing high-quality health services to residents. In June 2024, the establishment of the "Taiwan AI Labs" showcased significant advancements in the smart healthcare domain, with Asia Bay in Kaohsiung emerging as the world's first "generative AI industry cluster (Kaohsiung-1)" (Invest Kaohsiung, 2023c).

8) ESG and AI Innovation Center (September 2024)

SAP established the world's first "ESG and AI Research and Innovation Center" in Kaohsiung, facilitating sustainable supply chain management and carbon accounting solutions for local industries to meet net-zero compliance challenges. SAP, in collaboration with local partners, has developed an integrated carbon management platform called "Fastener Cloud 3.0" in response to the EU's CBAM regulations. This center is a strategic step toward advancing Kaohsiung's digital transformation in line with global standards (SAP official website, 2024).

9) Smart Agriculture

Farmers in Kaohsiung use the "Agri-Message" app to access cross-sector agricultural data, facilitating smart disaster prevention, market forecasting, and efficient farming. AI-driven decision-making tools assist in production planning, reducing risks, labor, and waste. An innovative AI-based lemon sorting system has significantly improved efficiency and accuracy (Kaohsiung Smart City, 2023).

In summary, Kaohsiung's comprehensive smart city strategy integrates cutting-edge technologies across a broad range of sectors, aiming to improve urban livability, foster industrial innovation, and position the city as a leader in global smart city development.

4. Policy support for city transformation

In terms of innovation theory, the early work of Joseph A. Schumpeter in "The Theory of Economic Development" (Xiao, 2015) introduced the concept of new combinations of production factors. Later, Michael Porter, in his "National Competitive Advantage" (Li & Qiu, 1996) elaborated on the innovation-driven model, which progresses through four stages: factor-driven, investment-driven, innovation-driven, and wealth-driven. Taiwan, lacking natural endowments, has relied on large-scale, capital-intensive investments by both central and local governments. Initially, these efforts focused on importing, learning, and mimicking advanced technologies from leading countries. Over time, these

efforts evolved into technological research, development, and innovation, establishing competitive advantages in emerging industries and cultivating leading and pillar industries. Throughout the city transformation process, the central government has formulated numerous development plans and subsidies, with local governments implementing corresponding measures to progressively drive societal and urban innovation through innovation-driven strategies.

4.1 Central Government Policy Foundation:

In November 2016, the Executive Yuan introduced the "Digital Nation and Innovative Economic Development Program (2017-2025)" (DIGI+ Plan), which completed its first phase (2017-2020). To align with the vision of a smart nation, it has been rebranded and upgraded to the "Smart Nation Plan (2021-2025)." This plan is integrated with previously approved major digital policies, such as the "Digital Construction of the Forward-Looking Infrastructure Development Program," the "Cybersecurity Industry Development Action Plan," the "Taiwan 5G Action Plan," and the "Taiwan AI Action Plan 2.0," aiming to transform Taiwan into an innovative, inclusive, and sustainable smart nation (Executive Yuan, 2024).

Under this framework, the Digital Industry Agency of the Ministry of Digital Affairs, in line with the Executive Yuan's "Forward-Looking Infrastructure Development Program," devised the "Smart Urban and Rural Living Applications Development Plan." This plan aims to accelerate the widespread adoption of digital services based on local and industrial needs. Utilizing the Public-Private-People Partnership (PPP) mechanism focuses on addressing key public concerns such as "health," "governance," "transportation," and "agriculture." It seeks to accelerate the implementation of smart applications, deepen digital governance capabilities, support private industries in their upgrade and transformation, and enhance citizens' smart living experiences. Ultimately, this plan aims to promote smart city applications across Taiwan, foster smart living, and facilitate exporting Taiwan's smart solutions abroad, creating a vision of shared urban-rural prosperity through digital technology (Smart City Taiwan, 2024).

Additionally, the National Development Council, in line with the Executive Yuan's "Asia Silicon Valley - 5G Innovation Applications Plan," aims to build upon the "Smart Urban and Rural 1.0" initiative. It promotes the integration of 5G, artificial intelligence, and the Internet of Things (AIoT) technologies, fostering the application and validation of services and business models in local contexts. Developing "Smart Urban and Rural 2.0" will advance 5G innovation applications, enhancing the maturity and operational sustainability of 5G smart solutions. This plan seeks to develop replicable and scalable 5G innovation services, addressing current and future lifestyle improvements while energizing domestic industries for digital transformation (Smart City & IoT, 2021).

In May 2023, the Executive Yuan approved the "Asia Bay 2.0 - Smart Technology Innovation Park Development Plan." This initiative focuses on four major strategies: expanding land use, expanding innovation, expanding clustering, and expanding exports. The Ministry of Economic Affairs (MOEA) has specially designed the "Asia Bay 2.0 International Smart Technology Research and Training Base Subsidy Program through smart technologies." This program aims to attract international smart technology companies to the park, fostering an R&D ecosystem that includes supply chain partners, local academia, and startups. Together, they will develop smart solutions, assist existing industries in transformation, and create high-value job opportunities. Moreover, it seeks to attract both domestic and international talent to contribute to target markets, ultimately establishing Asia Bay as an international hub for smart technology solutions (Ministry of Economy Affairs, 2024a).

In June 2023, the MOEA's Industrial Development Bureau launched the "5G AIoT Scaled Innovation Application Plan" under the "Industry Upgrade and Innovation Platform Counseling Program." This plan aims to transform Kaohsiung's Asia Bay into a large-scale 5G AIoT innovation technology testbed. It encourages industries to adopt 5G open network architectures and AIoT technology solutions at scale, promoting new 5G communication service models and fostering local industry upgrades. This initiative is designed to accelerate the construction of a self-sustaining 5G AIoT ecosystem and boost international market competitiveness by facilitating cooperation between Taiwan's 5G industry and global ecosystems (Ministry of Economic Affairs, 2024b).

4.2 Kaohsiung City Government Policy Initiatives:

To attract companies to the Asia Bay Innovation Park, the Kaohsiung City Government has introduced the "Kaohsiung Local Industry Innovation R&D Promotion Program" (Local SBIR), which provides resources for local industries to facilitate innovation and transformation. Since 2022, the city has partnered with the industry accelerator StarFab Accelerator to promote the "Building the Asia Bay Innovation Ecosystem Plan." This program encourages collaboration between large corporations and smaller startups, offering up to NT$1.3 million in incubation grants. It supports startups in securing international market orders and promotes innovative technology and business collaborations through a two-phase counseling and reward mechanism (Invest Kaohsiung, 2024d).

Additionally, the Kaohsiung City Government has implemented the "006688 Rent Incentive Program," offering subsidies for financing interest, rent, property taxes, and labor wages to help companies establish a foothold in the innovation park. The city government has also formed the "Invest Kaohsiung Team" and established the "Asia Bay Smart Technology Innovation Park Joint Service Center" to create a favorable investment environment. Key initiatives include park development, smart infrastructure, startup connections, field applications, talent cultivation, and industrial clustering (Invest Kaohsiung, 2024e).

5. Remarks

This case study in Kaohsiung provides a comprehensive overview of key strategies and methods for city innovation, focusing on Kaohsiung's transformation into a dual-axis smart city. Below are the essential approaches, key insights, and areas for potential improvement based on the content:

5.1 Essential Approaches for City Innovation:

1) Dual-Axis Transformation:

Digitalization and Net-Zero Emissions: Kaohsiung's transformation hinges on integrating digital technologies (e.g., AI, IoT, 5G) and promoting green policies to reduce carbon emissions. This dual-axis approach is aligned with global sustainability trends, ensuring that the city modernizes its infrastructure and addresses environmental challenges.

2) Industrial Transformation:

Kaohsiung leveraged its historical foundation in heavy industries (petrochemical, metal) to pivot towards high-tech smart manufacturing industries. The city now attracts tech giants through strategic investment and government policies, fostering clusters in semiconductors, AIoT, and smart machinery. These developments are crucial for upgrading traditional industries and reducing environmental pollution.

3) Smart City Infrastructure:

Integrating AI, cloud computing, and IoT in urban infrastructure (transport, public services, healthcare) facilitates real-time data collection, processing, and sharing. This promotes dynamic and efficient urban management, which is critical for addressing the complex needs of a growing population

4) Public-Private-People Partnership (3P Model):

Sustainable urban innovation requires collaboration across public sectors, private enterprises, and local communities. In Kaohsiung, this tripartite model enables the government to craft policies based on public demand while leveraging private sector expertise to implement technologically advanced solutions.

5) Smart Applications in Key Sectors:

Smart transportation (MaaS): Kaohsiung pioneered in Asia for implementing a Mobility as a Service (MaaS) system. This application of smart transportation technologies enhances urban mobility by utilizing real-time data for public transport management and event planning.

Smart energy and logistics: Kaohsiung port and logistics

industry, enhanced through AI and IoT, increases operational efficiency while reducing carbon emissions, showcasing the potential of smart technologies in industrial applications.

Smart petrochemical zones: The city is also leading in industrial safety innovations, incorporating AI-driven solutions to improve operational safety in petrochemical zones.

6) Innovation Ecosystem:

The Asia New Bay Area Smart Technology Innovation Park is a testing ground for 5G and AIoT applications, drawing in domestic and international firms to co-develop smart solutions. This park exemplifies how designated innovation hubs can accelerate the deployment and commercialization of cutting-edge technologies

5.2 This study also gained some insights:

1. Holistic Urban Transformation:

The success of Kaohsiung's innovation-driven transformation lies in its ability to balance environmental sustainability with economic modernization. This dual-focus ensures that the city grows while maintaining its commitment to reducing carbon emissions and fostering a green economy.

2. Industrial Clusters as Innovation Drivers:

By establishing robust industrial clusters (e.g., semiconductors and AIoT), Kaohsiung modernizes traditional industries and builds a sustainable foundation for high-tech innovation. This cluster-based approach aligns with Michael Porter's theory of competitive advantage, wherein related industries support one another's growth.

3. Government Support as a Catalyst:

Central and local government policies play a crucial role in Kaohsiung's transformation. The DIGI+ Plan and other national-level initiatives provide essential funding, regulatory frameworks, and strategic vision, enabling local governments to implement region-specific innovation policies.

6. Conclusions:

In conclusion, Kaohsiung's transformation into a human-centered, sustainable smart city highlights the power of strategic government support, public-private collaboration, and advanced technologies in driving urban innovation. Drawing from Michael Porter's innovation-driven model, this transformation emphasizes the importance of empowering individuals, enhancing public governance, and fostering a diverse and competitive industrial ecosystem.

Kaohsiung's efforts go beyond improving public services and citizen well-being; they aim to industrialize smart applications, establish a robust ecosystem, and export technological solutions globally. With its foundation in cutting-edge technologies and a dynamic innovation environment, Kaohsiung is reshaping its industrial and social structures. By continuing to shift towards high-tech industries and restructuring its labor market, the city can overcome traditional challenges and position itself as a leader in global smart city development. Kaohsiung has achieved some success in its transformation towards a smart city, but there are still areas worth continuing efforts in the future:

1) Scalability and Replicability: While Kaohsiung's success in building a smart city ecosystem is notable, future efforts should make these innovations scalable and replicable across other regions in Taiwan and globally. This involves refining 5G and AIoT applications to be more accessible to a broader range of industries and urban contexts.

2) Inclusive Innovation: To ensure that all residents benefit from innovative city technologies, there is a need to enhance digital inclusivity. Future improvements should address the potential digital divide, ensuring that underserved populations can access and benefit from the city's digital infrastructure.

3) Resilience to Global Challenges: As Kaohsiung continues to evolve as a smart city, building resilience against global challenges like pandemics, climate change, and economic downturns will be critical. This can be achieved by enhancing the flexibility and adaptability of its smart infrastructure to respond to unforeseen crises.

4) Enhancing International Competitiveness: While Kaohsiung has successfully attracted domestic and international firms, continued efforts are needed to ensure the city remains globally competitive. This could involve investing further in R&D, fostering international collaborations, and promoting Kaohsiung's smart city innovations globally.

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05

Transforming Mexico City Through Digital Public Innovation: The case study of the Digital Agency for Public Innovation

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Abstract

The Digital Agency for Public Innovation (ADIP) of Mexico City was established in 2018 under the administration of former Mayor and current President of Mexico, Claudia Sheinbaum. In just a few years, ADIP has become a cornerstone for digital transformation and innovation in Mexico City which is the largest city in Latin America. ADIP has implemented cutting-edge technologies that prioritize citizen engagement, technological independence, and smart governance. ADIP's achievements in data management, digital governance, and public service infrastructure have positioned Mexico City as a leader in urban innovation. The agency has managed to break free from dependence on expensive external consultancy and proprietary software licenses, developing a sustainable, open-source-driven model that other cities can learn from. This paper examines ADIP's development, its vital role in Mexico City's digital transformation, and the broader implications of having a dedicated agency managing digital initiatives for local governments. The findings provide adaptable ideas for other cities, supporting the broader goals of science-based, sustainable urban growth.

Keywords

Digital Government Innovation, Public Sector Digital Transformation, Urban Innovation, Public Digital Services, Citizen-Centric Governance

A brief introduction to Mexico City

> "The words we chose to describe our administration are Innovation and Rights. Innovation goes beyond data and technology; it is a philosophy aimed at improving the relationship between government, citizens, and technology."
>
> - Claudia Sheinbaum Pardo, President of Mexico.

Mexico City, the capital of the United Mexican States (Mexico), is centrally located in the Valley of Mexico. Known as Greater Mexico City or the Metropolitan Area of the Valley of Mexico, this area is one of the most expansive urban regions in Latin America, with around 22 million residents (see Figure 1) (INEGI, 2021). It ranks as the third most populous metropolitan area within the OECD and is the largest outside Asia, positioning it among the top ten largest cities worldwide (Harbering & Schlüter, 2020; Statista, 2024). As a dynamic megacity, Mexico City faces challenges in providing efficient access to essential services, such as healthcare, public records, and government programs, across a vast and diverse population

Figure 1. Key economic and demographic indicators of Mexico City

Source: INEGI (2021) & SEDECO (2020)

These challenges are further complicated by socio-economic disparities that limit access to technology and digital resources, making digital inclusion and equitable governance crucial priorities for the city. In response to this, former Mayor Claudia Sheinbaum prioritized digital innovation and fairness as central pillars of her administration, leading the city in December 2018 to take a major step forward its digital transformation journey with the publication of the Digital Operation and Innovation Law in the Official Gazette, which led to the establishment of the Digital Agency for Public Innovation (ADIP by its Spanish acronym), which was designed to make technology works for citizens, particularly the most vulnerable, by providing high-quality public services, addressing daily issues more efficiently, and ensuring transparent use of public funds assuming austerity as a commitment (Bloomberg, 2023).

This paper examines ADIP's development and high-impact projects, exploring how local government´s digital innovation can transform urban environments and provide valuable insights for other cities aiming to leverage technology for sustainable and inclusive urban growth.

Digital Governance for All

Built upon three core pillars: providing free internet access, enhancing government transparency, and developing digital tools to improve citizen services, ADIP is a pioneering force in modernizing public administration. Its integrated approach combines data-driven services, open and digital government practices, and technological governance, unifying all aspects of Mexico City's digital transformation under one central agency (see Figure 2) (Philanthropies & OECD, 2024; Vázquez, 2019).

Figure 2. ADIP - Transforming Mexico City's governance through technology.

Source: ADIP (2024)

As a people-first model for centralized innovation, ADIP has positioned Mexico City as a leader in digital innovation and smart city initiatives, effectively leveraging technology to simplify and enhance residents' lives (Goldsmith & Nagler, 2023). This approach has resulted in transformative projects, including the creation of an expansive free public WiFi network with over 31,000 hotspots, making Mexico City one of the most connected urban centers worldwide (Philanthropies & OECD, 2024). Furthermore, initiatives like Llave CDMX, a digital identification system offering single-point access to hundreds of public services, along with the integration of consolidated government platforms and open data policies, have established a unified digital interface for city services. This model, unprecedented in Mexico, has become a global benchmark for other cities (Bloomberg, 2023).

ADIP is responsible for developing and implementing policies related to data management, open government, digital government, and technology infrastructure. Its main objective is to establish a corruption-free government that effectively serves the people, especially those in need, by promoting a humanistic approach to digital governance and open data initiatives (ADIP, 2024). Table 1 summarizes ADIP´s objectives and functions.

Table 1. ADIP Key Objectives and Functions

Increase Transparency and Accountability	ADIP is working to create a digital record of all public funds, enhancing transparency and accountability in government spending.
Simplify Government Services	ADIP aims to streamline government services by eliminating unnecessary bureaucracy, simplifying processes, and establishing a one-stop shop for citizen services. This reduces the time and cost for citizens to interact with the government.
Reduce Corruption	By digitizing services and eliminating intermediaries, ADIP seeks to minimize opportunities for corruption and ensure that public services are used ethically and for their intended purpose.
Improve Citizen Engagement	ADIP is facilitating the digital transformation of public services, making it easier for citizens to interact with the government online. This reduces the need for citizens to physically visit government offices, saving them time and effort.

Expand Digital Connectivity	ADIP is committed to increasing internet connectivity throughout Mexico City, ensuring that all citizens have access to digital services and information.
Standardize Technology Procurement	ADIP is developing technology standards to streamline technology purchases by government agencies, ensuring efficiency and cost-effectiveness.
Promote Data-Driven Decision Making	ADIP is creating a comprehensive digital archive of city data and making it accessible to both the government and the public. This data can be used to inform policy decisions, conduct research, and promote a deeper understanding of the city.

Source: ADIP (2024)

Catalysts for Change in Public Service

Between 2019 and 2021, ADIP launched a total of 122 projects aimed at reshaping the landscape of public service delivery and digital governance in Mexico City. To gain a deeper understanding of ADIP's impact, this section examines three of its most significant and large-scale initiatives. These projects are among the agency's most representative efforts, illustrating its commitment to transparency, citizen empowerment, and technological innovation within the city's public administration. Through this review, we seek to highlight how these key initiatives contribute to ADIP's broader mission and its transformative role in Mexico City.

Free WiFi – The most connected city in the world

The expansion of free WiFi access points across Mexico City has transformed connectivity, establishing the city as a global leader in digital inclusion. By enabling access to the internet, the Free WiFi program provides a foundational digital infrastructure that facilitates access to essential rights and services for all residents. This initiative represents a fundamental step in Mexico City's digital transformation model, bridging the digital divide and positioning connectivity as a public good.

In 2018, Mexico City had just 98 free WiFi access points. By 2024, this figure had surged to an impressive 34,001, making the city one of the most extensively connected urban centers in the world. A substantial portion of these access points, 23%, are strategically located in public educational institutions, from primary schools to universities, ensuring that students across the city have the digital tools necessary for their education. Additionally, 13% of the access points were installed in residential complexes, benefiting approximately 2.5 million residents. Overall, the program has facilitated 110.2 million connections, with 12.3 million unique users and an average of nearly 5 million monthly users, highlighting its widespread impact (Batres, 2024; Gobierno de la Ciudad de México, 2024).

This remarkable achievement has earned Mexico City significant international recognition. In 2020, the city received the Guinness World Record as "the most connected city in the world" (Guinness World Records Limited, 2021). It was also awarded the Information and Communication Infrastructure Prize by the World Summit on the Information Society (WSIS, 2020). Furthermore, it was recognized as a regional best practice by the United Regions Organization in 2021 (ORU, 2021). These accolades underscore the program's success in promoting digital inclusion and setting a standard for other cities to emulate.

Tianguis Digital – Transforming Public Procurement in Mexico City

The Tianguis Digital platform, launched in 2019, is a landmark initiative aimed at revolutionizing public procurement through transparency, efficiency, and inclusion. Designed to monitor procurement processes end-to-end, this platform ensures that resources allocated to public contracting are invested responsibly and effectively. By offering a blend of public and private modules, Tianguis Digital provides tools for transparency, public accountability, and strategic management of procurement activities within the city.

An essential feature of Tianguis Digital is its emphasis on interoperability with other municipal and federal systems. By facilitating seamless communication with platforms such as the National Digital Platform and financial and tax systems, Tianguis Digital aligns with Mexico City's broader commitment to integrated digital governance. Furthermore, the platform adheres to international standards of open government, open data, transparency, and civic participation, solidifying its role as a model of government accountability in urban innovation. This alignment with international standards reinforces Mexico City's position as a progressive urban hub committed to open government principles and technological innovation. By digitizing and centralizing the procurement pipeline, the platform has made it easier for suppliers to explore business opportunities and for citizens to review the use of public resources.

Before the launch of Tianguis Digital, suppliers faced significant delays and bureaucratic hurdles; however, the new system has reduced response times by 66%, from over 15 days to an average of just 10 days. This improvement in operational efficiency has made public procurement not only faster but also more accessible and responsive to market dynamics. Another remarkable achievement is the number of registered suppliers, which surged from 1,700 in 2018 to 27,218 by the end of 2019, an extraordinary increase of 1,601%. This expanded supplier registry has fostered a more competitive procurement environment, leading to better service quality, lower costs, and a more diverse array of providers for city contracts.

Mi Tiendita Virtual – Fostering Inclusion in Public Procurement

As part of Tianguis digital in 2022, an initiative called Mi Tiendita Virtual (my virtual shop) was introduced to promote inclusivity within the public procurement ecosystem further. This project empowers priority sectors like small and medium-sized enterprises (SMEs), cooperatives, women-led businesses, individual women entrepreneurs, agricultural sectors, and indigenous communities by providing them with the knowledge and resources necessary to engage in government contracting. Through this program, these new vendors can display their products and services to government spending units, enhancing visibility, creating new business opportunities and closing the digital divide gap of the city.

Llave CDMX Expediente – A Citizen-Oriented Digital Transformation

Llave CDMX is an innovative digital access platform designed to streamline the management of procedures and services for Mexico City's residents. Serving as a central component of the city's digital transformation strategy, this platform integrates a single sign-on feature, a digital document repository, and a module for tracking the status of requested services. Through this initiative, Mexico City's government has redefined its relationship with citizens, making interactions with public institutions more accessible, efficient, and citizen-centered.

One of the key features of Llave CDMX is its transactional dashboard, which not only records the history of citizen-government interactions but also enables users to manage and follow up on various processes from a single location, enabling the "Once and Only" principle of digital government from the OECD (OECD, 2020). This administrative record system functions as a digital document rail, allowing any validated document to be reused across multiple transactions. Additionally, digital documents generated within government platforms are automatically added to users' digital files, providing citizens with easy access to important documents. This seamless integration bridges physical and digital interactions, ensuring continuity and ease of use for all users.

The platform was built using open-source code by ADIP's software development team. Fostering transparency, scalability, and accessibility. It also includes a humanistic approach prioritizing populations with structural and capabilities barriers to accessing government services through a support line. Furthermore, it verifies users' identities through official means, the platform mitigates risks associated with identity fraud, fostering a secure digital environment that safeguards citizens' data and builds trust in digital governance.

The impact of Llave CDMX on citizens' daily lives is substantial, saving both time and money by reducing the need for physical visits to government offices. With over 7 million active users and more than 70% of the city's service portfolio, the platform provides a unified access point that simplifies the application process. Through its Digital File feature, citizens can effortlessly select stored documents to initiate new procedures, making the process quick and reducing the bureaucratic burden. The addition of an electronic signature feature has also streamlined document validation, with 15,599 public servants now utilizing this digital tool to expedite approvals.

Beyond Mexico City, the success of Llave CDMX has inspired a strategic initiative to share its open-source code with other regions in Mexico. Through a code sharing program, ADIP seeks to empower other municipalities to replicate this digital authentication model, promoting a nationwide humanistic vision of accessible, human-centered digital governance. By extending its achievements beyond city borders, Llave CDMX exemplifies a commitment to fostering digital inclusion, not only for Mexico City's residents but for the entire country.

Decoding ADIP – A Perspective on Key Success Factors

This section presents insights from an interview conducted with Professor César Rentería Marín of the Division of Public Administration at the Center for Research and Teaching in Economics (CIDE) in Mexico. Having closely observed the evolution of Mexico City's Digital Agency for Public Innovation (ADIP) since its inception, Professor Rentería Marín provides a valuable academic perspective on the key success factors of ADIP.

1. Strategic approach

The first key factor in ADIP's success has been its strong legal foundation, established through the "Law on Operation and Digital Innovation for Mexico City". This legislation grants ADIP unique authority as the sole agency responsible for enforcing digital governance policies across the city. Operating with autonomy in technical, management, and operational aspects, ADIP reports directly to the Office of the Head of Government, ensuring it has both the independence and support necessary to drive innovation. A core component of its mandate is the coordination of data management, open government, and infrastructure governance policies, achieved through "Information Officers" designated within each government department. These officers are crucial links between the agency and city institutions, fostering seamless collaboration and alignment in implementing digital governance initiatives (Gobierno de la Ciudad de México, 2018).

2. Institutional Innovation

The second success factor was the prioritization of digital transformation with a strong emphasis on skilled human capital. The establishment of a "software factory" together with personnel with strong data science capabilities, ADIP not only produces the necessary applications and digital services that drive the city's technological infrastructure but also leads efforts in standardizing institutional processes to enable seamless interoperability across government departments. ADIP's scope extends beyond digitalization; it oversees the standardization of procurement processes for public purchases and technology acquisitions, ensuring consistency and transparency. Furthermore, the agency focuses on administrative simplification and regulatory improvements, aiming to streamline operations, reduce bureaucratic bottlenecks, and provide efficient, accessible services for citizens. This comprehensive approach to institutional innovation has been a crucial success factor in transforming Mexico City, aligning it with the principles of a modern, interconnected digital government.

3. Centralization

The third key element is centralization. Before ADIP's establishment, each government institution in Mexico City managed its digital initiatives independently, lacking standardized mechanisms for oversight and accountability. With ADIP's centralized coordination of the city's digital innovation strategy, resources are now used more efficiently, and all efforts align under a unified vision focused on citizen benefit. As a decentralized agency directly accountable to the Head of Government, ADIP has the autonomy to drive cohesive digital transformation across institutions.

Taking the leadership of data, enables the agency to set the standards on open data while also providing valuable data resources for government projects. By designing standards for information uniformity, data processing, and web system integration, ADIP facilitates data exploitation across departments, fostering high-impact projects and enhancing transparency. This centralized approach not only improves efficiency but also ensures that all digital initiatives are geared toward creating value for citizens and promoting an open, responsive government.

4. Quick wins

Finally, to establish its legitimacy across various government sectors, ADIP concentrated on delivering high-impact projects with minimal resources during its initial months of operation. In its first 100-day report (ADIP, 2019), ADIP highlighted over 40 achievements accomplished in collaboration with different city government actors. Key successes included saving 307 million pesos by renegotiating telecommunications contracts, launching a unified citizen service system, and expanding free WiFi access with over 13,000 additional access points. These rapid and visible results helped ADIP build trust among city institutions, fostering an environment conducive to collaboration and acceptance of digital transformation and being recognized internationally for its pioneering role in digital governance (see Figure 3). By demonstrating tangible benefits early on, ADIP effectively established a foundation of credibility and support, setting the stage for a sustained commitment to innovation and digital governance across Mexico City.

Figure 3. ADIP's Global Recognition.
Source: ADIP (2024)

Conclusions

- Through its commitment to expanding digital access, Mexico City has redefined urban connectivity, transforming free internet from a luxury into a human right. This initiative not only enhances the quality of life for millions of residents but also positions the city as a leader in urban digital innovation, serving as a model for cities worldwide seeking to implement similar connectivity strategies.
- ADIP´s projects represent a pioneering approach to public procurement within the framework of urban digital transformation. By integrating a new standard for public procurement in Mexico City, ensures that public contracting is conducted in a manner that is accountable to citizens and beneficial to vendors.
- While incorporating a humanistic citizen-oriented approach, the agency serves as a model of urban innovation for other cities seeking to modernize their government structures using ADIP as a case study in leveraging technology for public benefit, transparency, inclusivity, and citizen engagement that underpins a resilient urban future.
- The success of ADIP can be attributed to several key factors: a robust legal framework that supports the agency's authority, the centralization of digital governance under a single coordinating organization, and a proactive, agile approach grounded in data-driven decision-making. ADIP's impact goes beyond merely introducing technology and digitizing processes; it redefines administrative workflows, simplifies tasks, and drives regulatory improvements. Together, these elements have allowed ADIP to effectively lead Mexico City's digital transformation, establishing a model of efficient, transparent, and citizen-focused governance.

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06

Transforming Peru's Agricultural Sector through Smart Technologies and Data Integration

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Abstract

This paper examines the impact of technological advancements in Peru's agricultural sector, emphasizing their role in promoting sustainable growth, enhancing resilience to environmental challenges, and positioning Peru as a leader in agro-industrial exports. Renowned for its agricultural diversity, Peru's agricultural sector is a major contributor to the national economy, yet it faces challenges from climate variability, resource limitations, and a pressing need for improved efficiency. To address these issues, the Peruvian government has prioritized the adoption of smart farming technologies through initiatives like the Agricultural Innovation for Rural Development Project (PIADER) and the Integrated Agricultural Statistics System (SIEA). These technologies—including satellite image analysis, data analytics, and ICT—facilitate real-time monitoring, data-driven decision-making, and resource optimization, boosting productivity and promoting sustainable practices. Through PIADER and SIEA, Peru has implemented a structured approach to agricultural data management, equipping stakeholders with reliable, integrated information essential for effective policy development and strategic planning.

Keywords

Agriculture,
Statistics System,
Smart Farming Technologies

Introduction

Peru, located in South America, is globally recognized for its diverse microclimates and high biodiversity, positioning the country as a powerhouse in agricultural productivity and agro-industrial exports. Ranked among the top six most biodiverse nations, Peru's natural capital contributes over 22% to its GDP and accounts for at least 24% of exports (UNDP, 2022; MIDAGRI, 2021). This rich biodiversity, documented by the United Nations Development Program (UNDP), includes 84 of the world's 117 life zones and 28 of the 32 global climates, making Peru home to around 25,000 plant species—10% of global flora diversity (UNDP, 2022). Therefore, Peru stands as an ideal location for cultivating a wide variety of food crops.

The agricultural sector's impact extends beyond direct contributions, with the World Bank highlighting its essential role in economic growth and diversification. Agriculture contributes directly 7.3% of Peru's GDP and indirectly adds at least 4% through links to the food system (Morris et al., 2018). Since 1998, agricultural exports have shown impressive growth (Figure 1), with an annual average increase of 12.5%, making it the second-largest economic contributor. These exports have become a central economic driver, growing from under 1% of GDP in 1993 to 4% by 2022 (MIDAGRI, 2022).

Figure 1. Agriculture export growth in USD Million-FOB (2000-2023)

Source: MIDAGRI- Directorate of Economic Studies (2024)

Furthermore, the sector supports employment, particularly in urban informal areas, employing the largest segment of the workforce in 2021 at 27.5%. Given the agricultural sector's vast economic contributions, the World Bank underscores the need for regionally focused strategies to enhance productivity across Peru's diverse regions, ensuring sustainable growth and economic stability (Morris et al., 2018).

The purpose of this project is to present how the Peruvian government is supporting the development of agriculture, with such a diverse geographic area, and its stakeholders through the implementation of smart technologies, such as satellite image analysis, data analytics, actor identification, and real-time data integration. These technologies aim to enhance agricultural productivity, optimize resource use, and promote sustainable practices across Peru's wide-ranging agricultural regions.

Importance of Smart Technologies for Agriculture Sector

Smart technologies have become vital for enhancing agricultural productivity, optimizing resource use, and managing the effects of climate change (Mandal et al., 2024). These technologies offer precise and adaptable solutions for addressing the specific needs of agricultural landscapes, particularly in biodiverse and climate-sensitive regions like Peru. By implementing satellite imagery examination, data analytics, smart farming applications enable real-time monitoring and improved management of water, soil, and crop health, crucial for supporting sustainable agricultural practices and responding efficiently to markets demands.

International organizations such as the Food and Agriculture Organization (FAO) and the United Nations Conference on Trade and Development (UNCTAD), recognizes the importance of incorporating smart technologies, such as Agro-informatics, satellite imagery, Machine learning, enable data-driven farming and enhance decision-making. Alongside, to address climate change impacts and improving natural resource management, boost production, and enhance early warning systems (FAO, n.d.; UNCTAD, 2023). Consequently, digital tools in agriculture can enhance productivity and optimize water and soil management, crucial for sustainable development in environmentally sensitive regions like Peru.

Hence technologies such as satellite imagery play a transformative role in agriculture by enhancing crop monitoring, productivity, and sustainability. These technologies provide crucial data on crop health, soil conditions, and environmental factors, allowing farmers to make informed decisions that optimize yields and resource use. Additionally, satellite technologies enable real-time responses to climate challenges and natural disasters, making agriculture more resilient (Kyung et al., 2024). As a result, these advancements not only improve production efficiency but also strengthen the resilience of agriculture to environmental and economic challenges.

Project Precedents

The Agricultural Innovation for Rural Development Project (PIADER) was declared viable in June 2014 by the Executing Unit for Sectoral Project Management (UEGPS), part of Peru's Ministry of Agricultural Development and Irrigation (MIDAGRI). The project aims to enhance the quality, relevance, reliability, and availability of agricultural information in Peru, supporting more effective policy formulation and increased farmer income. Implementation began in 2016 under loan agreement No. 3272/OC-PE, structured around two primary components: (1) improving the agricultural statistical information system, and (2) providing information to producers through ICT in collaboration with the private sector (UEGPS, 2024).

In 2017, PIADER launched a sub-project to develop a nationwide map of current land use at a 1:10,000 scale, which resulted in the 2018 creation of the National Agricultural Land Map. This map, with various land-use categories, serves as a sampling frame for statistical operations like the National Agricultural Survey (ENA), agricultural planning, and statistical analysis. Initially, the project analyzed satellite images from RapidEye, an earth observation satellite constellation, constructing nationwide satellite mosaics for digital image processing. This process enabled updates to the national road network, populated centers, and digital classification of land cover types. Although the results were successful, the images analyzed dated back to 2012.

Therefore, to further enhance mapping accuracy, the project was updated in 2018 to use Sentinel-2 and Google Earth images, marking a turning point in national mapping efforts. By mid-2018, agricultural land surface data was updated through digital image processing for cartographic

production, yielding 24 regional maps. This enhanced map not only provides up-to-date data but also supports more effective decision-making, resource planning, and coordination of national statistical operations (Figure 2). Officially adopted in 2020 under Ministerial Resolution No. 0322-2020-MIDAGRI, the map is now widely used for various analyses and provides essential information for stakeholders across the sector (MIDAGRI, 2021).

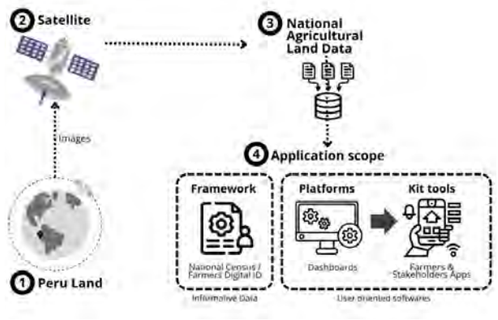

Figure 2. Data Reception Flow through Satellite Imagery Enabling Smart Farming Applications

Components of the Project

I. Component I: Enhancement of the Agricultural Statistics System

This component aims to improve the quality and timeliness of statistical data for public policy makers and investors. Reliable statistical information on agricultural production enables policymakers to design and target sector-specific policies effectively.

II. Component II: Information Provision to Producers via ICT through the Private Sector

The goal of this component is to provide small and medium producers with useful market-related information to improve production and marketing decisions. This is achieved through mechanisms that involve private sector participation and the use of information and communication technologies (ICT).

Scope of applications

Satellite imagery processing plays a vital role in modern agriculture by enabling efficient data collection, environmental monitoring, and decision-making tools for stakeholders. In Peru, the use of cartographic data generated by satellites supports a wide range of applications, enhancing statistical operations, technological tools, and direct resources for farmers. This classification of applications encompasses six key areas (Figure 3):

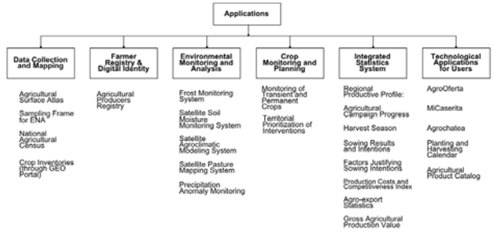

Figure 3. Key Area's Applications for Agricultural Data Management and Analysis

1. **Data Collection and Mapping** provides foundational geographic and agricultural data to support various statistical operations (Figure 4).

- Agricultural Surface Atlas: Provides a detailed geographic map of agricultural lands, aiding in land use planning and analysis.
- Sampling Frame for the National Agricultural Survey (ENA): Establishes a representative baseline of agricultural data for statistical accuracy in surveys.
- National Agricultural Census: Compiles comprehensive data on agricultural demographics, production, and resources.
- Crop-specific Inventories (Potato and Rice): Detailed inventories accessed through the GEO Portal, offering crop-specific data for better management and forecasting.

Figure 4. Identification of agricultural areas

Source: SIEA (n.d.)

2. **Farmer Registry and Digital Identity** creates a centralized digital profile for each farmer, enabling data tracking and crop classification.

- Agricultural Producers Registry: Creates digital profiles for farmers, enabling efficient data tracking, crop classification, and personalized support (Figure 5).

Figure 5. Digital Identity Platform for Agricultural Producers (A digital platform providing Peruvian farmers with personalized identification, crop valuation, real-time monitoring, and access to essential agricultural resources).

Source: Midagri (2022)

3. **Environmental Monitoring and Analysis** delivers real-time insights on soil moisture, frost risks, agroclimatic conditions, and precipitation anomalies, aiding in risk management and crop optimization.

- Frost Monitoring System: Uses temperature data to map frost risk areas, helping to mitigate potential crop damage.
- Satellite Soil Moisture Monitoring System: Measures soil moisture to assess drought impacts, enabling informed water management decisions.
- Agroclimatic Modeling System: Provides climate-based data to recommend profitable crops for specific regions.
- Pasture Mapping System: Monitors pasture conditions, supporting livestock management and sustainable grazing.
- Precipitation Anomaly Monitoring: Detects unusual precipitation patterns, allowing farmers to prepare for weather-related risks.

4. **Crop Monitoring and Planning** facilitates ongoing tracking of crop conditions and strategic intervention in priority areas.

- Monitoring of Transient and Permanent Crops: Tracks growth and health of seasonal and perennial crops, helping with yield predictions.
- Territorial Prioritization of Interventions: Identifies high-need areas to focus resources and improve agricultural planning.

5. **Integrated Agricultural Statistics System (SIEA)** consolidates essential agricultural data into accessible dashboards, helping stakeholders make informed decisions on production, exports, and costs.

- Regional Productive Profile: Provides data on regional crop volumes, prices, and types, supporting market alignment and resource allocation (Figure 6).
- Agricultural Campaign Progress: Monitors the progress of various agricultural campaigns to assess productivity and effectiveness.
- Harvest Season Tracking: Tracks seasonal harvests, helping in supply chain management and market planning.
- Sowing Results and Intentions: Reports on planting outcomes and future planting plans to aid in production forecasting.
- Factors Justifying Sowing Intentions: Analyzes factors influencing crop planting decisions to support strategic planning.
- Production Costs and Competitiveness Index: Details cost structures and competitive metrics, guiding efficiency improvements.
- Agro-export Statistics: Tracks export data, supporting global market strategies.
- Gross Agricultural Production Value: Calculates overall production value, highlighting economic contributions of agriculture.

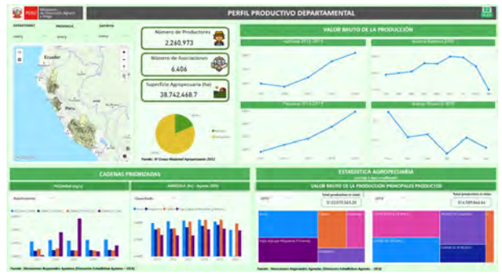

Figure 6. Regional Productive Profile Dashboard (A comprehensive dashboard displaying Peru's regional agricultural statistics, production trends, and priority crop data to support informed decision-making in agricultural planning).

Source: SIEA (n.d.)

6. **Technological Applications for Users** provides practical tools—such as market platforms and crop calendars—that bring valuable information directly to farmers and consumers.

- AgroOferta: A marketplace connecting producers with buyers, improving market access.
- MiCaserita: An app that connects local farmers with consumers for direct purchases (Figure 7).
- Agrochatea: A chat-based tool providing real-time advice and support to farmers.
- Planting and Harvesting Calendar: Guides farmers on optimal planting and harvesting times based on regional data.
- Agricultural Product Catalog: A digital marketplace for agricultural products, facilitating trade between producers and buyers.

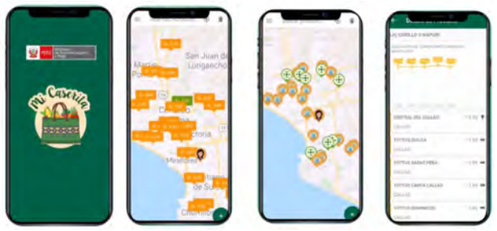

Figure 7. Mi Caserita app. (Mobile app that provides the location of nearby principal markets to check real-time reference prices of essential foods).

Source: SIEA (n.d.)

This structured approach to agricultural data management highlights the Peruvian government's role in strengthening the country's agricultural sector, supporting both strategic planning and practical, user-focused tools for sustainable growth.

Expected Results and Impact

The modernization and integration of the Agricultural Statistics System through smart technologies have significantly strengthened agricultural activities in Peru. This enhanced system reduces redundancies, minimizes statistical discrepancies, and facilitates the integration of diverse sectoral data for cohesive analysis (UEGPS, 2021). By enabling comprehensive, multi-perspective analysis and meeting diverse data needs through a flexible master sample, the system deepens understanding of the agricultural sector. Consequently, it provides stakeholders with integrated, reliable information that is essential for informed decision-making and effective policy development.

PIADER continue in 2020, as its Operational Manual was updated to reflect new guidelines and procedures. The project's continuity was secured in 2021 through Ministerial Resolution N° 0266-2021, allocating regular funding resources for its execution and setting a projected completion by 2024, aiming to consolidate its impact on family farming and the national agricultural sector. (UEGPS, 2024).

Conclusion

Peru's efforts to digitalize agriculture through smart farming technologies underscore a strategic response to both the country's rich biodiversity and its growing role in global agricultural markets. By implementing satellite imagery, data analytics, and ICT systems, Peru's agricultural sector can effectively support real-time monitoring and informed decision-making, benefiting both policymakers and producers. Initiatives like the Agricultural Innovation for Rural Development Project (PIADER) and the Integrated Agricultural Statistics System (SIEA) illustrate the country's commitment to optimizing productivity while ensuring sustainable practices across diverse agricultural zones. Smart farming technologies not only strengthen agricultural resilience and efficiency but also position Peru to address climate variability, improve resource management, and drive economic stability through sustainable agricultural development.

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