EUROCHAM
CAMBODIA

KONRAD
ADENAUER
STIFTUNG

FUTURE OF CITIES

10|2022

Edited by
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DIGITAL INSIGHTS

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ABOUT EUROCHAM CAMBODIA

EuroCham Cambodia was created in 2011 by the existing French, German and British business associations to act as the official chamber of the European business community in the Kingdom. Since then, it has grown to over 330+ members and 6 national chapters, comprising 11 European countries. EuroCham Cambodia's core activities are to promote, support and represent its members and European business interests in dialogue with the Royal Government of Cambodia, with the aim of developing a more efficient and fertile business and investment environment.

ABOUT KONRAD-ADENAUER-STIFTUNG

Freedom, justice and solidarity are the basic principles underlying the work of the Konrad-Adenauer-Stiftung (KAS). The KAS is a political foundation, closely associated with the Christian Democratic Union of Germany (CDU). As co-founder of the CDU and the first Chancellor of the Federal Republic of Germany, Konrad Adenauer (1876-1967) united Christian-social, conservative and liberal traditions. His name is synonymous with the democratic reconstruction of Germany, the firm alignment of foreign policy with the trans-Atlantic community of values, the vision of a unified Europe and an orientation towards the social market economy. His intellectual heritage continues to serve both as our aim as well as our obligation today. In our European and international cooperation efforts, we work for people to be able to live self-determined lives in freedom and dignity. We make a contribution underpinned by values to helping Germany meet its growing responsibilities throughout the world.

KAS has been working in Cambodia since 1994, striving to support the Cambodian people in fostering dialogue, building networks and enhancing scientific projects. Thereby, the foundation works towards creating an environment conducive to social and economic development. All programs are conceived and implemented in close cooperation with the Cambodian partners on central and sub-national level.

In the modern world, the meaning of cities for liberty and freedom, innovation, education, and development cannot be underrated. At the same time, cities are a threat to sustainability, personal health, and well-being. The future of the planet is decided in the world's major cities. And they are growing faster than at any time in history, putting a strain on services and infrastructure. Today, more than half of humanity – 4.2 billion people – lives in cities. By 2030, it is estimated that six out of ten people will be city dwellers. They will be living in 43 megacities with more than 10 million inhabitants in each city, most of them in developing regions. However, some of the fastest-growing urban agglomerations are cities with fewer than 1 million inhabitants, many of them located in Asia and Africa. Cities account for 60-80 percent of global energy consumption and 75 percent of global carbon emissions, despite occupying only 3 percent of the planet's surface. The rapid rise of urbanisation put pressure on freshwater supplies, sewage, the living environment, and public health. As a result of growing urbanization, the city suffers congestion, a lack of basic services, a shortage of adequate housing, and declining infrastructure. Technology-driven advancements are expected to be at the forefront of solving the myriad challenges associated with urbanisation, but they must be properly understood and implemented effectively to ensure the cities of the future are cities we want to live in.

Therefore, cities are at the core when it comes to the megatrends of digitalisation and sustainability. Alliances for these trends between cities have been formed all around the globe. Numerous Smart City Alliances and Sustainability Alliances of all sizes have emerged. Unfortunately, there is a lot of buzz wording surrounding the topic: smart cities, sustainable cities, livable cities which lacks a clear definition. The smart city starts with articulating a vision and goals – and since the entire point is to respond more effectively and dynamically to people's needs and desires of residents, any strategy must begin with people. Many smart city initiatives have failed because they focused on technology instead of on what people want and how they behave. Engaging the public from the outset, not just after specific solutions suddenly appear, can secure community buy-in. The participation of citizens in the development process is highly needed.

The ASEAN trend is more in a smart direction than in a sustainable direction – at least in its name. During Singapore's ASEAN chairmanship in 2018, the ASEAN Smart City network (ASCN) was established. As so often with ASEAN initiatives, they look good on paper but don't always pan out in reality. The ASCN concept note acknowledges the importance of cities for economic development, and also its challenges. Most of ASEAN's growth has been and will continue to be, driven by urban centers, with an additional 90 million people expected to urbanize by 2030. "Middleweight" cities of between 200,000 to 2 million residents are forecasted to drive 40% of the region's growth. However, rapid urbanization comes with its challenges as it has implications on important issues such as city congestion, water, and air quality, poverty, rising inequalities, urban-rural divide, citizen security, and safety. Technological and digital solutions can be utilized to resolve these issues and enhance the quality and accessibility of services, thereby improving our citizens' lives across the urban-rural continuum, creating new opportunities, and ensuring that no one is left behind. The ASCN is envisioned as a collaborative platform where up to three cities from each country work towards the common goal of smart and sustainable urban development. The network is mainly focused on improving the life of a citizen, using technology as an enabler. It aims at building smart cities in a way that is inclusive and respectful of human rights and fundamental freedoms. With its impressive development, Singapore takes the lead as a role model in these open platforms, but the gap in development among the member cities will not be easy to bridge. In addition to facilitating business partnerships and working relations, Singapore has branded itself as a resource provider in ASCN. Various capacity-building efforts were visible in Singapore's engagement with the member cities mainly via Government-led think tanks such as the Centre for Liveable Cities (CLC). The starting project of the member cities reflects the different levels of development. While Singapore's priority areas are Digital Government, Digital Economy, and the Digital Society, with one of the first projects being the establishment of a National Digital Identity, Phnom Penh's focus areas are building efficient and green infrastructure, a healthy environment, and civic engagement. In one of the first initiatives, Phnom Penh aims to increase pedestrianisation through rejuvenation, restoring, and repurposing of the sidewalks for 11 boulevards.

In Cambodia too, urbanisation is growing at over 3% per year – and with a population of around 2.3 million people, Phnom Penh is quickly emerging as one of Southeast Asia's newest commercial hubs. As the urban population grows, city planners must address rising air, light, and sound pollution. They will have to develop efficient energy, waste, and water management strategies to ensure that the city is safe and secure and that there are clean and green spaces for city dwellers to enjoy. Importantly, they must also devise new ways for the growing population to be transported efficiently and safely around the city. This leads to the question of How smart Cambodian cities are. As the mentioned example of Phnom Penh sidewalks shows, not so much at the moment. The projects of the other Cambodian members also symbolize that the Cambodian cities need to catch up with basic infrastructure and are not yet focusing on the use of data or the interconnectivity of data and infrastructure to make a city "smart". They pay attention to issues such as the environment (e.g., drainage and sewage systems, garbage collection), infrastructure (e.g., building new markets, building pedestrian walks), and safety (e.g. traffic sensors or CCTV). There is a lot to learn and to improve.

Therefore, the latest edition of Digital Insights aims to tackle these challenges, provide a platform for sharing diverse perspectives, catalyze public-private collaborations, and most importantly, shine a light on the potential solutions that will shape the cities of the future. Digital Insights is an annual publication that discusses the digital transformation in Cambodia. Previous editions covered Sustainability, the Future of work, and E-Governance. We would like to thank the authors and editing team for their incredible contribution. We wish all our readers a super interesting journey through this book.

Tassilo BRINZER
Chairman
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Dr. Daniel SCHMÜCKING
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What will the cities of the future look like? How will cities adapt to urbanization, increased pressure on public infrastructure and utilities, and how will policymakers ensure that new "smart city" technologies are implemented in a safe, efficient and ethical manner? Will our cities overcome these challenges to become more pleasant places to live, or become dystopian sprawls?

The answers to these questions and many more are discussed in the latest Digital Insights publication. At its center, besides disruptive trends such as the internet of things (IoT), climate change, big data (and data privacy), was also the aspect of Covid-19, and how the pandemic forever changed our relationship with the urban environment.

The new issue of Digital Insights is a collaborative project between EuroCham Cambodia and the Konrad-Adenauer-Foundation Cambodia (KAS). In this latest edition, EuroCham and KAS bring together a diverse group of authors, academics, and practitioners, to view the future of cities from different perspectives in a constructive manner. Our distinguished authors enlighten us with insights into the impact of disruptive technological innovations that are shaping the future of cities, specifically within the Cambodian context.

Cities are hubs for human productivity and ingenuity - contributing to over 80% of global GDP (World Bank, 2020), and they are changing at a rapid pace. There are several benefits to urbanisation - notably, urbanisation rates tend to rise alongside GDP per capita. Today, more than half of humanity – 4.2 billion people – live in cities, and by 2030, more than 60% of us will live in urban environments.

This rapid trend of urbanization is particularly visible in Phnom Penh, where previously sleepy riverside districts such as Chroy Changvar have seen an influx of investment, and on Koh Pich, where every month a new building transforms Phnom Penh's skyline. Ambitious new strategies such as the Cambodia Digital Economy and Society Policy Framework 2021-2035 provide a vision for how technology will shape the lives of future city dwellers. At the same time, new infrastructure projects are under development, servicing the needs of Phnom Penh's growing population (2.3 million people, increasing at 3% per year). New malls are popping up to satisfy retail demand, new airports to match Phnom Penh's status as an emerging economic hub, and new waste and water treatment facilities to improve the health of the urban population.

Rapid urbanization, of course, brings several challenges – how to balance growth with sustainability, how to manage congestion, and how to ensure urban growth does not contribute to inequality. Fortunately, many of these challenges have digital solutions, or at least, technologies that can alleviate their negative impacts.

This latest issue of Digital Insights dives down into these solutions and provides critical analysis. Our authors discuss general trends regarding smart cities, they discuss specific Cambodian case studies, how resources can be allocated more efficiently, how buildings could be developed in a more sustainable manner, how disruptive technology can improve public transport networks, and how data from urban citizens should be collected, used and managed. In addition, our authors discuss how core elements of urban life may be transformed in the future – for example; citizen engagement, smart education, smart healthcare, digital banking and payments, including via the cross-sectoral applications of blockchain technology.

Our hope is that this publication contributes toward the development of equitable, safe, and improved urban environments in Cambodia. In many cases, our authors, from students to academics, to private sector leaders, have suggested practical recommendations to ensure that Cambodia's cities realise their future growth potential, and have pointed out risks that should be considered by policymakers regarding disruptive trends and technologies.

We sincerely thank our contributors – they have provided us with both insightful academic studies, as well as more direct explorations of how to make the cities of the future the best they can be.

A special focus of this issue of Digital Insights is, of course, what the future of work holds for Cambodia and Cambodians. What path will Cambodian policymakers take in light of the challenges described above? How will the built environment change? What challenges does the Kingdom's government face? With this book, we hope to contribute to the discussion around these questions.

Enjoy reading, and let's shape the future of our cities successfully together!

Thomas HESKETH   **Oudom OUM**

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WHAT MAKES A SMART CITY, SMART?

**An Analysis of the Economist Digital Cities Index 2022,
and how Phnom Penh Compares to the World's Most Digitized Cities.**

JESSICA TJANDRA   **NOUN UKSA**   **THOMAS HESKETH**

Abstract

For our paper, we wanted to understand what makes a smart city, smart. Fortunately for us, the Economist Impact recently published its very first Digital Cities Index (DCI) 2022[1] - "A Global Benchmark of Urban Technology". This wonderful publication provides a set of 48 indicators to measure just how "smart" global cities are. We would like to thank the Economist Impact for making this Index publicly available, and for its public challenge to researchers to add new cities to its ranking. In our paper, we have answered this challenge, attempting (at a high level) to assess Phnom Penh against the DCI indicators, and to understand how the Cambodian capital compares to its global peers.

Introduction

As humanity races through the 21st century, urban administrators have built digital infrastructure, and increasingly integrated digital technology into their municipal services. Disruptive technologies, such as artificial intelligence (AI), the Internet of Things (IoT), cloud computing, and 5G connectivity, are providing municipal authorities with a new set of tools, enabling them to address urban intelligence, cleanliness, and inclusivity with greater competence than ever before.

The Digital Cities Index (DCI) 2022 offers a global ranking of 30 cities across four pillars: connectivity, services, culture, and sustainability. High ranking cities have good connectivity and are "5G and AI" ready. They embrace digital services in sectors such as government services, healthcare, and digital finance, promote digital awareness among their citizens, and employ technology to create a more sustainable environment.

In our short desk study, we attempted to take the newly launched Digital Cities Index and expand it to one more city – Phnom Penh. We believe this index could be a useful tool to measure Phnom Penh's progress towards a digital future. By raising awareness of the DCI, we also hope to inform policymakers about the quantifiable metrics they could use to improve Phnom Penh's standing against its global peers.

Background

The term "Digital City" refers to a city that has access to the internet and technology platforms for information and communication management. Cities all over the world are developing digital infrastructure, and are increasingly integrating digital technologies into urban management.

The Digital Cities Index (DCI) 2022 offers a global ranking of 30 cities across four thematic pillars: connectivity, services, culture, and sustainability. Figure 1 shows the detailed framework of each pillar.

The results of the DCI, which include quantitative and qualitative analysis from 3,000 residents from the assessed cities (100 from each city), demonstrate how well-performing the cities are in terms of both quantitative measures such as internet speed, and qualitative characteristics such as the presence of strategies, policies, and plans for technologies like 5G and AI.

1. Economist Impact. (2022). Digital Cities Index 2022.

Figure 1: Framework of Digital Cities Index

Figure 2: Top 5 cities in each DCI ranking pillar: connectivity, services, culture, and sustainability

The inaugural Digital Cities Index 2022 provides a global ranking of 30 cities across four thematic pillars: connectivity, services, culture an sustainability. The overall top five cities are:

| 1 Copenhagen | 2 Amsterdam | 3 Beijing | 4 = London | 4 = Seoul |

The top five cities in each pillar are:

Connectivity	Services	Culture	Sustainability
1 Copenhagen	1 Copenhagen	1 New York	1 Copenhagen
2 Singapore	2 Berlin	2 Washington DC	2 Seoul
3 Zurich	3 London	3 Toronto	3 Toronto
4 Beijing	4 Amsterdam	4 Copenhagen	4 Barcelona
5 Sydney	5 Singapore	5 = Dallas 5 = Seoul	5 Beijing

Provision of accessible, affordable and good quality infrastructure to enable digital connection

Provision of digital services by public and private sections for better education, healthcare, financial services, transport and retail services

Incorporation of technology into everyday lives through creation of an innovative ecosystem and a safe online environment, and citizen engagement

Deployment of technologies for environmentally friendly growth through resource management and emissions reduction

The World's Most Digitized Cities

According to the DCI Ranking, Copenhagen, Amsterdam, Beijing, London, and Seoul are the five most digitized cities in the world. Figure 2 shows the top five cities in each pillar of the DCI Ranking.

In this section, we analyze the top 5 cities, and the factors and initiatives that allowed them to achieve such high rankings. The purpose? We believe policymakers and development agencies working in Cambodia could learn from such initiatives, potentially adapting them to the Cambodian context.
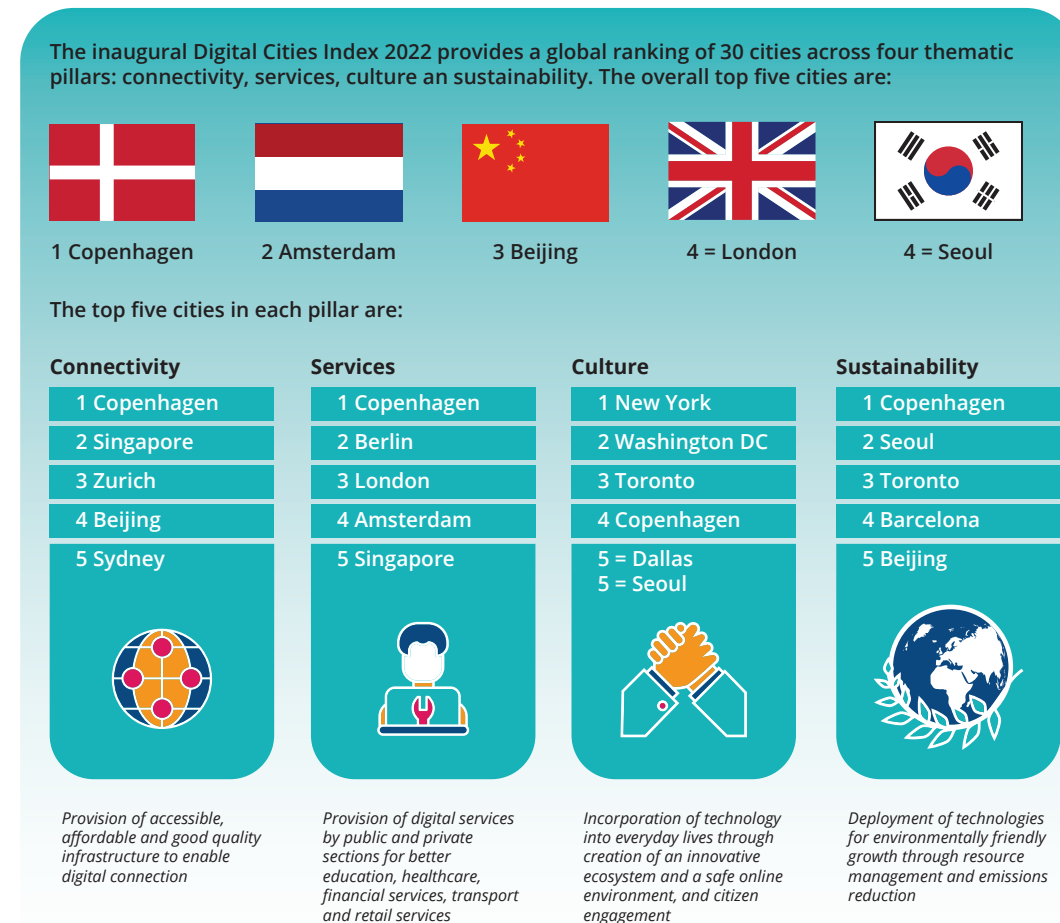
Copenhagen

According to the DCI Index, Copenhagen ranks first in each pillar except for culture. In terms of its connectivity, Copenhagen leads the rank through initiatives such as "Copenhagen Connecting", a smart city initiative that supports the integration of technology and services through data collection from various sources, including mobile phones, GPS, and sensors in the waste system. Copenhagen uses this data to reduce congestion, pollution, and emissions in the city[2].

Furthermore, assessing the service pillar, Copenhagen takes the lead by being one of only seven cities worldwide that have invested in digital tourist permits, which provide access to

2. Kjolberg, T. (2015). Copenhagen Connecting. Daily Scandinavian. Retrieved 1 August 2022, from https://www.dailyscandinavian.com/copenhagen-connecting/.

attractions and transportation[3]. In addition, Copenhagen also ranks fourth in the world in its digital finance sector, currently housing up to 50 fintech startups[4].

While Copenhagen "only" ranks fourth in terms of culture, it nevertheless performs best among developed economies in terms of satisfaction with e-government portals, with 58 per cent of the DCI respondents saying they feel comfortable using such portals[5].

Finally, evaluating its sustainability pillar, Copenhagen, like other European cities, scores full marks in the use of IoT-enabled traffic management. Furthermore, whereas most cities lack the strategy to promote a 'sharing economy' system, Copenhagen is amongst the cities with action plans to support the scheme. Some of the sharing economy options easily accessed by Copenhagen citizens include affordable tool libraries, car and bike share schemes, free 3D printers in the library, and even clothes swapping[6].

Amsterdam

Amsterdam places high in the DCI Ranking due to its connectivity and sustainability pillars. Firstly, it is a thriving and innovative tech hub that houses one of the largest data exchanges in the world, the Amsterdam Internet Exchange (AMS-IX)[7].

In terms of sustainability, like Copenhagen, Amsterdam scores full marks in the use of IoT-enabled traffic management. Furthermore, in 2015, Amsterdam increased its investment in smart traffic management, with use cases including adaptive traffic light control to relieve traffic congestion and reroute traffic; traffic trend analysis to strengthen situational assessment and lower accident rates; and camera technology for enforcing environmental zone regulations and limiting access of vehicles that are not environmentally friendly[8].

Beijing

Beijing ranks fourth in terms of its connectivity and fifth in terms of its sustainability. Beijing ranks high for its connectivity as the city offers high-quality internet connections at an affordable price. According to Speedtest Global Index in June 2022, China ranks third in the world for its fixed broadband connection with an average download speed of 188.03 Mbps[9]. Furthermore, the price for its internet connection is also relatively cheap at 147 yuan, or around 20 USD, for 8 Mbps a month[10].

In its services pillar, Beijing ranks first for its digital finance and healthcare indicators. In 2020, China's AliPay and WeChat Pay platforms had by far the most users of mobile payments. Digital healthcare in China has also developed rapidly as the number of online medical users climbed from 214.8 million in December 2022 to 233.33 million

in June 2021[11]. Moreover, digital healthcare has drawn significant investment, with a total financing amount exceeding USD 1.9 billion in 2018. With the COVID-19 outbreak, the digital pharma industry and consultation are getting more popular in the country.

Given its historical challenges in terms of air quality, Beijing's fifth rank in terms of sustainability is highly commendable[12]. In the late 1990s, Beijing implemented significant policies to curb emissions and pollution, including optimizing energy infrastructure, controlling vehicles emission, and cutting coal-fired pollution, which resulted in a 35% reduction in fine particulate matter pollution[13]. Moreover, the city has implemented an IoT-based program called Green Horizons to estimate pollution levels based on factors including traffic, weather, humidity, and wind patterns[14].

London

London's overall rank is boosted highly by its sustainability. In terms of its sustainability indicators, London ranks first in terms of efficient resource management and second in terms of pollution management. Like many European cities, London is investing heavily in air pollution innovation. After an initial pilot phase that started in 2018, London has recently launched the Breathe

London network, a comprehensive air quality monitoring system that will be implemented from 2020 to 2024[15]. These sensors are small, versatile, and can be placed on lamp posts, traffic lights, and playgrounds. The data collected from these sensors is used to inform policymakers on the overall air quality and geographic distribution of air pollution throughout the city.

Seoul

Seoul is ranked fifth and second in terms of the culture and sustainability pillars respectively, putting its rank on par with London. Seoul is among the most AI-ready cities in the world, as the government has planned to invest USD 287 million in 2022 in over 1000 digital projects[16], including establishing its own metaverse platform, expanding the use of AI-powered CCTV, and developing blockchain-based services[17].

Seoul is also one of the few cities with a "sharing economy" system in place, a concept built around the equitable sharing of resources. In 2012, the Seoul government implemented the Sharing City Soul, with one objective being to increase government investment in "sharing enterprises". Seoul has 97 certified sharing enterprises today, including a car-sharing platform, SoCar, and Open Closet, a company that allows young job seekers to borrow donated business attire[18].

3. The City Pass on your phone. Copenhagencitypass. com. (2022). Retrieved 1 August 2022, from https://www. copenhagencitypass.com/en/how-it-works/.

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ASEAN Highlights

Among the 30 cities assessed in the DCI Ranking, 5 cities are located in Southeast Asia: Singapore, Kuala Lumpur, Bangkok, Jakarta, and Manila. Across the region, there are vast disparities in the digitization of the cities. Singapore unsurprisingly leads within the region, placing 8th worldwide, while Manila performs the worst, placing at the bottom of the 30-city ranking.

Singapore performs very well in terms of connectivity, placing second. In 2020, the Singaporean government announced its plan to invest SGD 25 billion in AI, 5G, and cyber security to boost the country's growth and innovation post-Covid[19]. Singapore also places high in terms of its services pillar, particularly on its e-government services due to its mobile digital national ID card program. Its Smart Nation and Digital Government Group (SGFinDex), which enables people to access financial information held across various government agencies and financial institutions, is the first public digital infrastructure in the world to use a national digital identity and a centrally managed online consent system[20].

There are several notable digitization achievements by the other ASEAN countries noted in the DCI Whitebook. First, the Government of Thailand developed the TAGTHAi Pass, in cooperation with tourism businesses to provide tourists with access to various tourism-related services[21]. Second,

Jakarta launched JakWifi in 2020 to provide free Wi-Fi to residents in the city[22].

Figure 3: Results of the DCI Index 2022[23]

Overall Score		
1	Copenhagen	81.5
2	Amsterdam	74.6
3	Beijing	73.7
=4	London	73.6
=4	Seoul	73.6
6	New York	73.3
7	Sydney	72.6
8	Singapore	71.4
9	Washington DC	71.2
10	Paris	70.2
=11	Toronto	70.1
=11	Zurich	70.1
13	Barcelona	69.7
14	Frankfurt	69.1
15	Dallas	68.7
16	Berlin	68.2
17	Hong Kong	68.0
18	Dubai	63.8
19	Madrid	63.2
20	Tokyo	63.0
21	Rome	61.2
22	Auckland	60.1
23	Kuala Lumpur	58.2
24	São Paulo	50.7
25	Bangkok	49.1
26	Buenos Aires	45.1
27	Jakarta	43.5
28	Mexico City	42.6
29	New Delhi	40.3
30	Manila	39.1

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A Critical Analysis of Phnom Penh Against DCI Indicators

Through this paper, our objective was to assess where Phnom Penh would stand within the DCI ranking using the same weightings and indicators.

Methodology:

Though we were not able to obtain a sample of 100 Phnom Penh based respondents to match the rigour of the DCI, we were able to produce quantitative estimates for most DCI indicators. Our estimates are based on publicly available data, data aggregation websites, qualitative assessment by the authorship team, and a thorough desk review of relevant policy documents. Though imperfect, our objective was to provide an approximative assessment of Phnom Penh's ranking. At an indicative level, we believe we have achieved this aim. Our hope is that future researchers can carry out the Phnom Penh assessment more robustly, or indeed that Economist Impact itself could include Phnom Penh in future renditions of the DCI, using primary data obtained from Phnom Penh residents.

If we promote active discussion, we have succeeded in our aim, and we very much welcome further research that can strengthen and refine the initial scores we have given.

Overall Results

Our detailed calculations, and the sources for our scorings are shown in Figure 6 of the Annex. Overall, we found that Phnom Penh has a score of 42.7, which would place Phnom Penh 28th in the new sample of 31 cities, and just above Mexico City, New Delhi, and Manila. Phnom Penh scores the highest on the connectivity pillar with a total score of 56.8, followed by the services pillar at 40.4, the sustainability pillar at 38.6, and last, the culture pillar at 29.7.

Figure 4: Scoring of Phnom Penh compared to Singapore (Highest in ASEAN) and Manila (Lowest).

Comparison to ASEAN Capitals

■ Singapore ■ Phnom Penh ■ Manila
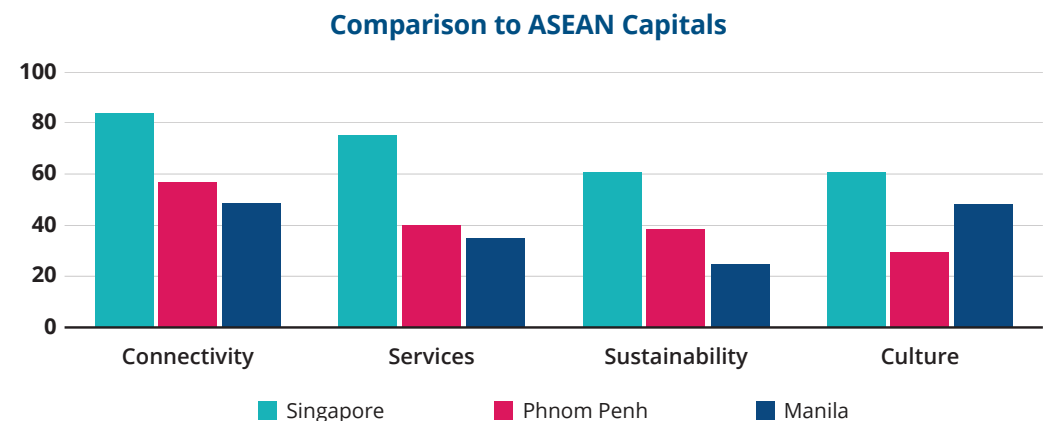
Connectivity

The DCI measures connectivity based on digital infrastructure, quality, and affordability.

Phnom Penh's connectivity score (56.8) is boosted by a high score on the affordability sub-indicator, as Cambodia enjoys some of the most affordable mobile data rates in the world. Further improvements on the connectivity indicator could be made on digital infrastructure, especially on 5G readiness and 5G deployment.

Services

The services pillar (scoring 40.4) consists of the following sub-indicators: E-gov services for residents and businesses, digital finance, transportation, education, and retail and hospitality.

Within the sub-indicators, Phnom Penh ranks the highest in the education, healthcare, and e-gov services sectors, with scores of 100, 71.0, and 50.4, respectively. Based on the Economist Impact Survey used in The Inclusive Internet Index 2022, Cambodia scores perfectly on its digital education[24]. This is also supported by the findings from UNESCO, which found that during the pandemic, the Ministry of Education, Youth and Sports provided pre-recorded lessons for all grade levels on its Facebook and Youtube channels, as well as its e-learning website[25].

In the healthcare sector, the Royal

Government of Cambodia successfully implemented policies to help Cambodia in its fight against COVID-19 with the use of online tools for contact tracing and vaccine verification. The Ministry of Health also launched the first-ever health technology solution, the Smart Hospital e-Health Yoeung program, in 2020, which is utilized for online medical records as well as appointment scheduling via mobile phones[26].

Within the e-gov services, people can now register their businesses online, allowing them to register with multiple ministries in one go[27]. The use of this online business registration also allows for a faster processing time, with business registration processes approved at a maximum of 8 working days.

Finally, despite the strong growth in adoption rates, we discovered that Phnom Penh's digital finance score remains low, at least by the metrics used by the DCI (WorldPay data). This is because digital banking is still inaccessible to many of the socioeconomically disadvantaged, despite the rapid expansion of digital banking and e-payment service providers such as Wing Bank and ABA. This said, we expect that the digital finance score will see the greatest improvements of any sub-indicator in the very near future.

Culture

Phnom Penh's score in the digital culture pillar (29.7) could also be improved, predominantly due to low scores on cyber

security preparedness, cyber risk awareness, and limited AI readiness, among others. With the vision of becoming an upper-middle income country by 2030, these scores could be improved by further promoting education on digital technologies (such as via courses at the government sponsored Cambodian Academy of Digital Technology), which in turn would encourage the implementation of more informed cyber policies and practices In the future.

Sustainability

Finally, Phnom Penh scores relatively well on its sustainability pillar (38.6). Favourable government legislation and policies, including the law for net-zero emission and e-waste management contribute to this score. Despite that, drafted laws and legislation must be followed by strong implementation. Phnom Penh urban planners are in a strong position to follow the excellent examples of leading DCI cities (such as London's "Breathe London" initiative), in the use of technology to achieve more pleasant urban environments.

Recommendations for a Digital Phnom Penh

For a city to transform into a digital city, it must excel in four areas: Connectivity, Services, Culture, and Sustainability.

The connectivity pillar evaluates a city's infrastructure's capacity for digital connectivity and comprises three critical facets: digital infrastructure, quality of the infrastructure, and affordability.

The services pillar measures the degree to which citizens take advantage of digital services and enjoy the convenience and efficiency they provide, as well as the

interoperability between digital service providers and the integration of various services across digital platforms.

The culture pillar evaluates the level of technological integration into people's lives.

Finally, the sustainability pillar analyses the extent to which digital technologies are applied to achieve environmentally friendly growth through the adoption of a circular economy, effective resource management, emissions reduction, and pollution management.

Connectivity: Cities with a high DCI ranking are more likely to have good connectivity. Despite a high mobile penetration rate, Phnom Penh currently scores poorly in terms of digital infrastructure, with low uptake of fixed broadband subscriptions and limited access to 5G connections. The lack of digital infrastructure severely disadvantages individuals at the bottom of the pyramid, such as children who do not have access to online learning resources. Phnom Penh could take a cue from one of the ASEAN based DCI cities, Jakarta, which increased its spending on hotspots and free Wi-Fi for its citizens to pave the way for more rapid action to alleviate digital disparities. In terms of 5G implementation, investments from the public and private sectors as well as supportive regulatory conditions would be needed to support the transition.

Services: Evaluating the services pillar, high-ranked DCI cities are utilizing e-government, digital healthcare, and digital finance services. Singapore, for instance, has a mobile digital national ID card program as well as e-government services for businesses and residents. While Phnom Penh has yet to have a mobile digital national ID, the government has now started to expand digitization in business services. Business

24. Economist Impact, 2022. The Inclusive Internet Index 2022. [online] Available at: <https://impact.economist.com/projects/inclusive-internet-index/downloads/3i-executive-summary.pdf#:~:text=The%20Inclusive%20Internet%20Index%20%283i%29%2C%20produced%20by%20Economist,the%20Internet%20for%20personally%20and%20societally%20enriching%20purposes.> [Accessed 3 August 2022].

25. IIEP-UNESCO. 2022. Cambodia: Digital education is here to stay. [online] Available at: <http://www.iiep.unesco.org/en/cambodia-digital-education-here-stay-13492> [Accessed 3 August 2022].

26. Long, K., 2020. Ministry launches first-ever health technology solution. Phnom Penh Post, [online] Available at: <https://www.phnompenhpost.com/national/ministry-launches-first-ever-health-technology-solution> [Accessed 3 August 2022].

27. Registrationservices.gov.kh. 2022. Registration Services | Online Business Registration. [online] Available at: <https://www.registrationservices.gov.kh/en/home/> [Accessed 3 August 2022].

registration, for instance, can now be done fully digital using the CamDX[28]. Similarly, in terms of digital healthcare, Phnom Penh has made strides in online medical records as well as pandemic-related applications, employing online vaccination cards and tools to help with contact tracking or vaccine verification. Perhaps surprisingly, Phnom Penh's adoption rate for digital payments is still quite low in comparison to the other DCI cities, despite an uptick in recent years. The reason for this is that socioeconomically disadvantaged people tend to use non-bank digital payment providers, such as TruMoney instead of digital banking applications like ABA, incurring large transaction costs in the process. Phnom Penh, therefore, needs to increase the accessibility and affordability of digital payments. Fortunately, we know this is a high priority for the Royal Government, as demonstrated by the successful rollout of the Bakong payment system.

Culture: A city will not be able to properly turn into a digital city if its citizens lack appropriate technology awareness. As a result, through education, the Cambodian government may help its citizens become more equipped for the digital age, particularly in terms of cyber risk and cyber security readiness.

Sustainability: Finally, emerging cities, such as Phnom Penh, Jakarta, and Bangkok tend to have low sustainability performances, despite having the highest sustainability risks. Technologies including AI, sensors, and the IoT can all help to increase energy and resource efficiency in basic municipal services like water, power, lighting, and trash management. Beijing is a perfect example of a once emerging, now advanced city that has been using digital technology to reduce

air pollution. Initiatives such as Beijing's IOT based "Green Horizons" program demonstrate how emerging-market cities, like Phnom Penh, may use technology to effectively address environmental issues.

Conclusion

Our provisional scoring of Phnom Penh of 42.7, based on the Economist Impact DCI methodology is a commendable score for Cambodia's fast-growing capital, though there are certainly areas for improvement. By utilising the DCI indicators and sub-indicators as tools to guide digital progress, and by learning from the factors that have enabled the top-ranked cities to score so highly, we believe Phnom Penh is an excellent position to progress as one of ASEANs future smart cities.

Annex

Methodology Explained

We duplicated the methodology used by the DCI to provide scores for each indicator. The methodology, as described by the DCI, is copied directly below[29]. The indicators and sub-indicators for each pillar provide useful guiding statistics for urban planners to assess progress towards an increasingly digital Phnom Penh.

To enable a comparison of broader ideas between cities, indicator ratings are normalized to a standard unit and then aggregated across categories. All metrics in this model are scaled from 0 to 100, with 100 denoting the highest digitalization and 0 the lowest. Most indicators are transformed using a min/max normalization, in which the minimum and maximum raw data values across the 30 cities are utilized to bookend the indicator scores.

Weightings

The weighting used in the scoring also follows DCI experts-assigned weights. Figure 5 shows the weights used in the ranking, whereas Figure 7 shows the detailed list of sub-indicators of the pillars.

29. Economist Impact. (2022). Digital Cities Index 2022.

Figure 5: DCI indicators and weightings

DCI expert-based weightings:

Table A1.1: Overall Weights	
Category	**Weights (%)**
1. Connectivity	30%
2. Services	28%
3. Culture	21%
4. Sustainability	21%

Table A1.2: Indicator Weights	
Indicator	**Weights (%)**
1. Connectivity	
1.1. Digital infrastructure	44.44%
1.2. Quality	22.22%
1.3. Affordability	33.33%
2. Services	
2.1. E-gov services for residents & businesses	19.23%
2.2. Digital finance	15.38%
2.3. Transportation	19.23%
2.4. Healthcare	15.38%
2.5. Education	15.38%
2.6. Retail and hospitality	15.38%
3. Culture	
3.1. Digital inclusion	18.75%
3.2. Government support	31.25%
3.3. Innovation ecosystem	31.25%
3.4. Public attitude and engagement	18.75%
4. Sustainability	
4.1. Efficient resource management	27.78%
4.2. Emissions reduction	27.78%
4.3. Pollution	22.22%
4.4. Circular economy	22.22%

28. Registration Services | Online Business Registration. Registrationservices.gov.kh. (2020). Retrieved 2 August 2022, from https://www.registrationservices.gov.kh/en/home/.

Calculation of Phnom Penh's Scores on the Digital Cities Index Indicators

In cases of incomplete data, qualitative scoring was used based on author's analysis. The authorship team would like to emphasise that figures are indicative. Using different sources could of course yield differing results, different authors may ascribe different scores to each indicator. That said, the scores obtained still achieve our primary objectives of 1) raising awareness of the DCI; 2) attempting to assess Phnom Penh's standing; and 3) providing an indication of where Phnom Penh could improve in its attempts to digitalise.

Figure 6: Author's calculation of Phnom Penh's ranking on the Digital Cities Index

INDICATORS	WEIGHTS	SCORING	SOURCE
1. Connectivity	**30%**	**56.8**	
1.1. Digital infrastructure	**44.40%**	**35.5**	
1.1.1. Mobile broadband subscriptions	28.9%	49.8	ITU, Knoema
1.1.2. Fixed broadband subscriptions	22.2%	0	ITU, Knoema
1.1.3. 5G readiness	20%	33.3	B2B Cambodia
1.1.4. 5G deployment	28.9%	50	Ookla 5G Map based on EIU
1.2. Quality	**22.20%**	**47.7**	
1.2.1. Internet upload speed	28.57%	36	Ookla Speed Test Intelligence
1.2.2. Internet download speed	32.14%	10.9	Ookla Speed Test Intelligence
1.2.3. Mobile broadband latency	17.86%	70	Ookla Speed Test Intelligence
1.2.4. Fixed broadband latency	21.43%	100	Ookla Speed Test Intelligence
1.3. Affordability	**33.30%**	**91.3**	
1.3.1. Mobile data affordability	52.17%	100	Cable
1.3.2. Fixed broadband affordability	47.83%	81.9	Qualitative scoring by the author's analysis based on the average broadband cost and disposable income from CES
2. Services	**28%**	**40.4**	
2.1. E-gov services for residents & businesses	**19.23%**	**50.4**	
2.1.1. Mobile digital national ID	32.14%	0	Qualitative scoring by author's analysis
2.1.2. E-gov service portal for residents	35.71%	51	United Nations Divisions for Public Institutions and Digital Government

INDICATORS	WEIGHTS	SCORING	SOURCE
2.1.3. E-gov service portal for businesses	32.14%	100	CamDX
2.2. Digital Finance	**15.38%**	**0**	
2.2.1. Digital platforms for banking and personal finance	34.29%	0	Qualitative scoring by author's analysis based on a report from ACLEDA Bank
2.2.2. Digital investment management tools	22.86%	0	Qualitative scoring by author's analysis
2.2.3. E-payments	42.86%	0	WorldPay, Qualitative scoring by author's analysis based on Phnom Penh Post
2.3. Transportation	**19.23%**	**23.1**	
2.3.1. Integrated public transport apps	53.85%	0	Qualitative scoring by author's analysis
2.3.2. Digital identification at airports	46.15%	50	Qualitative scoring by author's analysis
2.4. Healthcare	**15.38%**	**71.03**	
2.4.1. Telehealth & telemedicine	31.58%	66.6	Economics Impact Country Research
2.4.2. Electronic health records	36.84%	50	Qualitative scoring by author's analysis based on Phnom Penh Post
2.4.3. Pandemic-related applications	31.58%	100	Qualitative scoring by author's analysis
2.5. Education	**15.38%**	**100**	
2.5.1. Digital Education	100.00%	100	Economist Impact Country Research
2.6. Retail and hospitality	**15.38%**	**0**	
2.6.1. E-commerce penetration	56.52%	0	Qualitative scoring by author's analysis
2.6.2. Digital tourist passes	43.48%	0	Qualitative scoring by author's analysis
3. Culture	**21%**	**29.68**	
3.1. Digital inclusion	**18.75%**	**70.8**	
3.1.1. Internet usage	36.84%	51.2	Datareportal
3.1.2. Gap between female and male access to the internet	31.58%	100	Gallup

INDICATORS	WEIGHTS	SCORING	SOURCE
3.1.3. Digital skills	31.58%	64.6	Economics Impact Survey
3.2. Government support	**31.25%**	**23.2**	
3.2.1. Data protection law	20%	50	Qualitative scoring by author's analysis based on Phnom Penh Post
3.2.2. Cyber security preparedness	20%	0	National Cyber Security Index
3.2.3. Cyber security risk awareness	20%	25	National Cyber Security Index
3.2.4. Open data access and use	20%	0	Economist Impact Country Research
3.2.5. Internet freedom	20%	41	Freedom House
3.3. Innovation Ecosystem	**31.25%**	**12.8**	
3.3.1. AI readiness of government	22.41%	0	Oxford Insights
3.3.2. Blockchain technology strategy	12.07%	66.6	Qualitative scoring by author's analysis. An example of a blockchain technology strategy is Bakong by NBC.
3.3.3. Tech startup ecosystem	24.14%	0	StartupBlink
3.3.4. Intellectual Property Rights	18.97%	25	EIU
3.3.5. Business environment	22.41%	0	World Bank
3.4. Public attitude and engagement	**18.75%**	**27.5**	
3.4.1. Online public comfort	50.00%	55	Qualitative scoring by author's analysis based on EIU
3.4.2. E-participation in government portals	50.00%	0	Qualitative scoring by author's analysis
4. Sustainability	**21%**	**38.6**	
4.1. Efficient resource management	**27.78%**	**41.5**	
4.1.1. Smart utility management	50.00%	25	Qualitative scoring by author's analysis
4.1.2. Smart urban agriculture	21.05%	0	Qualitative scoring by author's analysis
4.1.3. Smart construction	28.95%	100	Qualitative scoring by author's analysis based on Cambodia Constructors Association
4.2. Emissions reduction	**27.78%**	**55.1**	
4.2.1. Net-zero emission	32.43%	100	Qualitative scoring by author's analysis based on drafted law

INDICATORS	WEIGHTS	SCORING	SOURCE
4.2.2. Traffic management	37.84%	60	Qualitative scoring by author's analysis
4.2.3. Support for autonomous vehicles	29.73%	0	Qualitative scoring by author's analysis
4.3. Pollution	**22.22%**	**14.8**	
4.3.1. Air pollution	100.00%	66.7	IQAir
4.4. Circular economy	**22.22%**	**38.1**	
4.4.1. Development of sharing economy	61.90%	0	Qualitative scoring by author's analysis
4.4.2. E-waste management	38.10%	100	Sub-decree on E-Waste Management" endorsed by the Cambodian Government on February 1st, 2016
OVERALL SCORE		**42.7**	

Figure 7: Detailed list of DCI sub-indicators per pillar

Table A1.4: Detailed list of sub-indicators				
Indicator	**Definition**	**Unit**	**Source**	**Type**
Connectivity				
1.1 Digital Infrastructure				
1.1.1 Mobile broadband subscriptions	A measure of mobile broadband subscriptions with high-speed access to the internet. Subscriptions that have access to the internet via fixed-line networks are not included.	per 100 inhabitants	International Telecommuni-cation Union (ITU); Economist Intelligence Unit (EIU)	Quantitative
1.1.2 Fixed-line broadband subscriptions	A measure of fixed broadband subscriptions with high-speed access to the internet, including both residential subscriptions and subscriptions for organisations. Subscriptions that have access to the inernet via mobile-cellular networks are not included.	per 100 inhabitants	ITU; EIU	Quantitative

Table A1.4: Detailed list of sub-indicators

Indicator	Definition	Unit	Source	Type
1.1.3 5G readiness	An assessment of national or local strategy or initiatives to promote 5G. Cities receive a higher score if the policy or strategy recognises multiple use cases of 5G such as fixed wireless access (FWA), enhanced mobile broadband (eMBB), massive machine-type communications (mMTC), the Internet of Things (IoT) and ultra-reliable low-latency communications (URLLC).	Score (0-3)	Qualitative scoring by Economist Impact analysts	Qualitative
1.1.4 5G deployment	An assessment of the stage of 5G deployment, varying from pilots and testing to deployment for commercial use.	Score (0-2)	Qualitative scoring by Economist Impact analysts	Qualitative
1.2 Quality				
1.2.1 Internet upload speed	A measure of the speed at which a user can send data from their mobile device to the internet.	Mbps	Ookla	Quantitative
1.2.2 Internet download speed	A measure of the speed at which a user can pull data from a server on the internet to their mobile device.	Mbps	Ookla	Quantitative
1.2.3 Mobile broadband latency	A measure of the time it takes for data or a requests to go from the source to the destination when using mobile broadband.	ms	Ookla	Quantitative
1.2.4 Fixed broadband latency	A measure of the time it takes for data or a request to go from the source to the destination when using fixed broadband.	ms	Ookla	Quantitative
1.3. Affordability				
1.3.1 Mobile data affordability	A measure of the cost of 1GB of mobile data as a proportion of individual personal disposable income.	%	Cable, EIU	Quantitative
1.3.2. Fixed broadband affordability	A measure of the cost of fixed-line broadband subscriptions as a proportion of individual personal disposable income.	%	EIU	Quantitative
Services				
2.1.E-gov services for residents & businesses				
2.1.1 Modbile digital national ID	An assessment of the availability of a digital national ID that can be accessed and displayed on a mobile device in the form of a scannable code or a digital replica of the physical ID card, for the purpose of online and offline verification.	Score (0-1)	Qualitative scoring by Economist Impact analysts	Qualitative

Table A1.4: Detailed list of sub-indicators

Indicator	Definition	Unit	Source	Type
2.1.2 E-gov service portal for residents	An assessment of whether a country provides its residents with information about laws and policies; platforms offering help links, tutorials on online tools and online skills development; and functionalities that allow for the use of e-services like application for visas, ID cards and social protection.	Score (0-1)	United Nations Division for Public Institutions and Digital Government	Quantitative
2.1.3 E-gov service portal for businesses	An assessment of official government portals for business functions such as digital or remote business registration, payment of duties and grant applications.	Score (0-2)	Qualitative scoring by Economist Impact analysts	Qualitative
2.2.Digital finance				
2.2.1 Digital platforms for banking and personal finance	A measure of adoption of and satisfaction with apps or digital platforms that replace traditional functions of banking such as deposit, withdrawal, loans and monitoring spending.	%	Economist Impact survey	Survey
2.2.2 Digital investment management tools	A measure of adoption of and satisfaction with apps or digital platforms to access financial markets and manage personal investment portfolios of equities, bands, mutual funds or other financial instruments.	%	Economist Impact survey	Survey
2.2.3 E-payments	A measure of the value of e-payment made as a share of total retail sales. E-payment plaforms considered include: • Traditional card transactions such as Visa/Mastercard • Mobile payment apps that integrate payments from traditional card issuers such as Apple Pay • Mobile payment wallets such as PayPal/Square/Alipay	%	WorldPay	Quantitative

Table A1.4: Detailed list of sub-indicators

Indicator	Definition	Unit	Source	Type
2.3. Transportation				
2.3.1 Integrated public transport apps	An assessment of whether residents have access to integrated transport apps with journey planning and ticketing functionality for the public transit system, provided by the government or by the private sector in collaboration with the public sector.	Score (0-3)	Qualitative scoring by Economist Impact analysts	Qualitative
2.3.2 Digital identification at airports	An assessment of whether the airport supports biometric identification at immigration control and at boarding gates to enable a completely automated process.	Score (0-2)	Qualitative scoring by Economist Impact analysts	Qualitative
2.4. Healthcare				
2.4.1 Telehealth & telemedicine	An assessment of the adoption of telehealth or telemedicine services (public or private) and their provision by health authorities, with the service being provided by professional medical staff.	Score (0-2)	Economist Impact survey: qualitative scoring by Economist Impact analysts	Survey and qualitative
2.4.2 Electronic health records	An assessment of the use of electronic health record (EHR) systems in the healthcare sector.	Score (0-2)	Qualitative scoring by Economist Impact analysts	Qualitative
2.4.3 Pandemic-related applications	An assessment of the presence of apps, mobile functionalities (iOS, Google wallet pss) or physical devices and tokens to aid in the verification of vaccination or contact tracing.	Score (0-2)	Qualitative scoring by Economist Impact analysts	Qualitative
2.5. Education				
2.5.1 Digital education	An assessment of plans, policies and initiatives adopted by the government to promote digital education. Digital education is the use of digital technologies and tools in teaching and learning and is also known as technology-enhanced learning (TEL) or digital learning.	Score (0-2)	Qualitative scoring by Economist Impact analysts	Qualitative
2.6. Retail and hospitality				
2.6.1 E-commerce penetration	A measure of e-commerce sales as a share of total retail sales. The measure includes purchases on any e-commerce shopping platforms, and excludes hybrid in-store shopping experiences.	%	WordPay	Quantitative

Table A1.4: Detailed list of sub-indicators

Indicator	Definition	Unit	Source	Type
2.6.2 Digital tourist passes	An assessment of the availablity of official digital tourist passes for access to attractions or transportation in a city. Any generic ride-sharing and hotel-booking apps that residents use day to day are excluded.	Score (0-1)	Qualitative scoring by Economist Impact analysts	Qualitative
Culture				
3.1. Digital inclusion				
3.1.1 Internet usage	A measure of indiviiduals that use the internet via a computer, mobile phone, personal digital assistant, games machine, digital TV, etc.	%	EIU; ITU; qualitative scoring by Economist Impact analysts	Quantitative and qualitative
3.1.2 Gap between female and male access to the internet	A measure of the difference between the number of women and men online.	%	ITU; Gallup	Quantitative
3.1.3 Digital skills	A self-assessment of digital skills by city residents, as captured in the Economist Impact survey. Digital skills can be defined as the ability to find, evaluate, use, share and create content using digital devices, such as computers and smartphones.	Score (0-100)	Economist Impact survey	Survey
3.2. Government support				
3.2.1 Data protection law	An assessment of whether the country/city has legislation on data protection, which is a set of privacy laws, policies and procedures that aim to minimise personal data theft.	Score (0-2)	Qualitative scoring by Economist Impact analysts	Qualitative
3.2.2 Cyber security preparedness	An assessment of the level of cyber security preparedness in the country. Cyber security is the application of technologies, processes and controls to protect systems, networks, programs, devices and data from cyber attacks.	Score (0-4)	EIU risk briefing	Quantitative

Table A1.4: Detailed list of sub-indicators

Indicator	Definition	Unit	Source	Type
3.2.3 Cyber security risk awareness	An assessment of whether there are initiatives undertaken by citizen groups, non-governmental organisations or governments to increase cyber security risk awareness. Cyber security has become important due to the ever-increasing cyber risk landscape, prompting the need to improve citizen awareness for self-protection.	Score (0-4)	Qualitative scoring by Economist Impact analysts	Qualitative
3.2.4 Open data access and use	An assessment of how governments publish and use open data for accountability, innovation and social impact.	Score (0-100)	Open Data Barometer	Quantitative
3.2.5 Internet freedom	An assessment of freedom of the internet, taking into account obstacles to access to the internet, limits on content and violation of user rights.	Score (0-100)	Freedom House	Quantitative
3.3. Innovation ecosystem				
3.3.1 AI readiness of government	An assessment of how ready a given government is to implement AI in the delivery of public services to their citizens.	Score (0-100)	Oxford Insights	Quantitative
3.3.2 Blockchain technology strategy	An assessment of whether there is a well-defined blockchain technology strategy in the country/city. A blockchain-based digital government strategy can protect data, streamline processes and reduce fraud, while simultaneously increasing trust and accountability.	Score (0-3)	Qualitative scoring by Economist Impact analysts	Qualitative
3.3.3 Tech startup ecosystem	An assessment of the quality and quantity of startups in a city, taking into account different metrics such as number of startups, number of co-working spaces and number of accelerators, to establish the activity level of the startup ecosysem.	Score	Startup Blink	Quantitative
3.3.4 Intellectual property rights	An assessment of the level of intellectual property protection which is critical to fostering digital innovation. Without protection of ideas, businesses and individuals would not be able to reap the full benefits of their inventions.	Score (1-5)	EIU	Quantitative

Table A1.4: Detailed list of sub-indicators

Indicator	Definition	Unit	Source	Type
3.3.5 Business environment	An assessment of the degree to which businesses can invest and operate in a free, open and competitive market, with policies and legal assurances that their rights and assets would be secure.	Score (0-100)	EIU	Quantitative
3.4. Public attitude and engagement				
3.4.1 Online public comfort	An assessment of residents' comfort in sharing their financial and personal details on various digtial platforms, such as e-commerce websites, e-payment apps, tracking apps (navigation, location), food delivery apps and ride-sharing apps, and the likelihood of cyber attacks and level of preparedness.	Score (0-100)	Economist Impact survey; EIU risk briefing	Survey and quantitative
3.4.2 E-participation on government portals	A measure of residents' awareness of and satisfaction with interactive e-platforms provided by the government.	%	Economist Impact survey	Survey
Sustainability				
4.1. Efficient resource management				
4.1.1 Smart utility management	An assessment of cities' utilisation of technologies in managing water, electricity and waste efficiently. Digital technologies like IoT and AI can be used to improve utility management and conserve precious resources.	Score (0-4)	Qualitative scoring by Economist Impact analysts	Qualitative
4.1.2 Smart urban agriculture	An assessment of wether the city has employed digital technologies in its agricultural activities. Smart urban agriculture refers to the use of digital technologies in farming activities within th city such that processes are smarter, sustainable and more efficient.	Score (0-1)	Qualitative scoring by Economist Impact analysts	Qualitative
4.1.3 Smart construction	An assessment of whether the city has employed digital technologies in its construction activities. Smart construction refers to the use of digital technologies in construction activities in the city to make construction smarter and more efficient.	Score (0-1)	Qualitative scoring by Economist Impact analysts	Qualitative

Table A1.4: Detailed list of sub-indicators

Indicator	Definition	Unit	Source	Type
4.2. Emissions reduction				
4.2.1 Net-zero emissions	An assessment of whether cities' have targets in place to achieve net-zero emissions in the foreseeable future and whether there are actions being taken to meet those targets in the form of policies, reforms or laws. "Net zero" is reached when greenhouse gases going into the atmosphere are balanced by those being removed. As digital technologies also contribute to greenhouse gas emissions, it is necessary for governments to balance their economic growth against emissions.	Score (0-2)	Qualitative scoring by Economist Impact analysts	Qualitative
4.2.2 Traffic management	An assessment of whether cities have employed technologies such as autonomous traffic lights that adapt to traffic conditions or that can be remotely controlled in order to manage congestion. The use of these technologies is assessed against the severity of congestion levels to ascertain whether congestion has been adequately addressed.	Score (0-5)	TomTom Traffic Index; qualitative scoring by Economist Impact analysts	Quantitative and qualitative
4.2.3 Support for autonomous vehicles	An assessment of government support for autonomous vehicle development and operation through the evaluation of policies. Autonomous vehicles are capable of reacting to their environment, improving fuel consumption and reducing congestion.	Score (0-2)	Qualitative scoring by Economist Impact analysts	Qualitative
4.3. Pollution				
4.3.1 Air pollution	An assessment of whether cities are installing air sensors on multi-functional/smart poles or street lights for granular air pollutioin data collection. The use of these technologies is assessed against the severity of the city's pollution levels to highlight th need for smarter tools to combat particle pollution.	Score (0-6)	IQAir; qualitative scoring by Economist Impact analysts	Quantitative and qualitative

Table A1.4: Detailed list of sub-indicators

Indicator	Definition	Unit	Source	Type
4.4. Circular economy				
4.4.1 Development of sharing economy	An assessment of government support for sharing-economy development through plans, policies, strategies or frameworks.\n\nThe sharing economy is an economic model in which goods and resources are shared by individuals and groups, usually through an online platform that acts as a virtual meeting place for suppliers and consumers. This leads to more optimal use of existing resources and reduces the demand for the production of new goods.	Score (0-2)	Qualitative scoring by Economist Impact analysts	Qualitative
4.4.2 E-waste management	An assessment of whether government have e-waste management policies/laws which target proper disposal or mandate re-use of e-waste, among other objectives. E-waste refers to discarded electrical items or electronic equipment and their parts without the intention of re-use.	Score (0-1)	Qualitative scoring by Economist Impact analysts	Qualitative

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Jessica recently joined EuroCham as Senior Investment Research Analyst, where she leads EuroCham's work on Green Energy Financing. Jessica is a graduate of Macquarie University in Australia where she graduated with a Master's in Applied Economics with a Distinction. She was awarded the Department of Economics Prize 2020 for her academic excellence. Her study encompasses micro-, macroeconomics, econometrics, as well as development economics. Post her master's study, she joined the UNDP in Cambodia as a Junior Socio-Economic Consultant, covering various works including the feasibility study of local currency government bond issuance, developing a crypto-based single registry for CSOs, poverty risk analysis, and Covid-19 Economic and Social Impact Assessment in Cambodia. She also joined Emerging Market Consulting as a Senior Business Analyst, working on private sector development.

NOUN UKSA

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ASEAN SMART CITIES NETWORK:
A Cambodian Perspective

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Introduction

In 2016 the United Nations (UN) has estimated that 54 percent of humanity lived in urban areas.[1] Across most high-income countries, the urban population surpasses 80 percent of the total, although the figure drops and varies between 50 to 80 percent in Eastern Europe, East Asia, North and Southern Africa, and South America.[2] From Figure 1, it is possible to see a visual map of Asia, retrieved from Our World in Data,[3] showing the share of people living in urban areas in the year 2020.

Figure 1: *Share of people living in urban areas*[4]

No Data 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
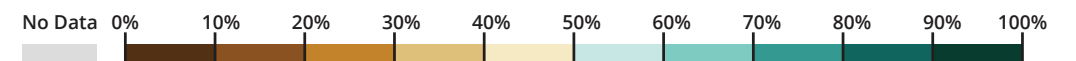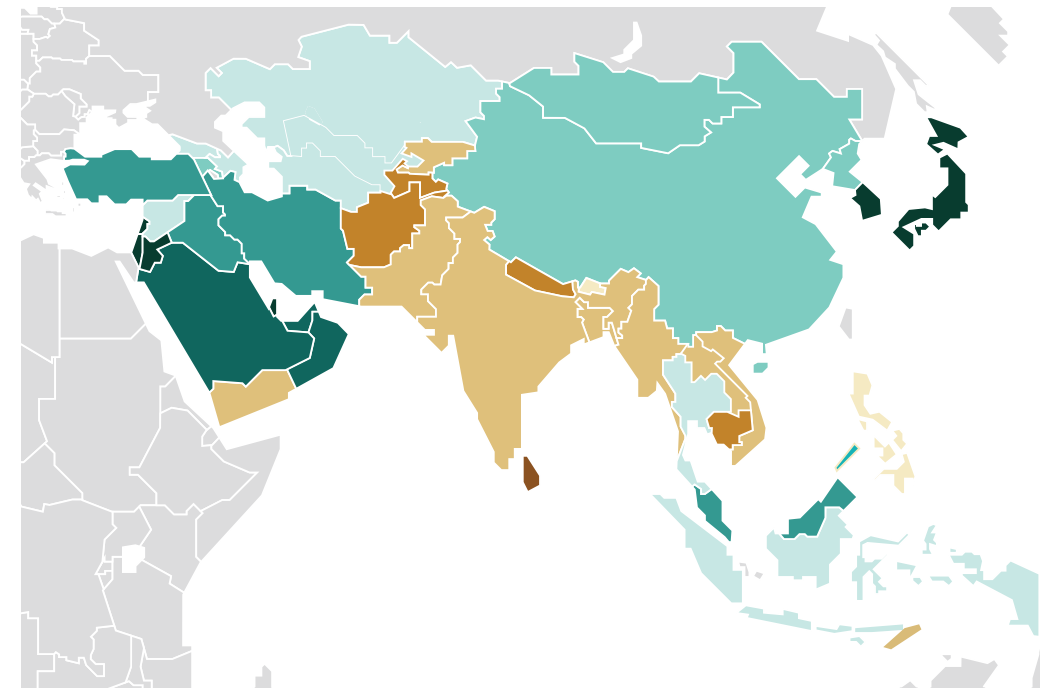
Source: UN Population Division (via World Bank)
Note: Urban populations are defined based on the definition of urban areas by national statistical offices.

Specifically with a focus on the Association of Southeast Asian Nations (ASEAN), the combined population of its member countries surpasses the 630 million figure, and by the end of 2030,

1.   UN. 2018. "UN World Urbanization Prospects." https://esa.un.org/unpd/wup/Download/.

2.   Ritchie, Hannah, and Max Roser. 2018. "Urbanization." Our World in Data, June. https://ourworldindata.org/urbanization.

3.   Ibid.

4.   Ibid.

an additional increase of 90 million in the ASEAN cities count has been forecasted.[5] Unfortunately, the region is experiencing a wide range of issues as a result of its rapid growth. For example, one of the biggest issues is the growing amount of traffic congestion and accidents, which are estimated to cost any city in the area between 2 and 5 percent of its Gross Domestic Product (GDP) each year.[6] In line with what has been observed in the region, Cambodia, the most recent ASEAN member (added in 1999), has also gone through this rapid urbanisation process. According to information from Our World in Data, 10.29 percent of Cambodians lived in urban areas in 1960. In 2000, this percentage rose to 18.59 percent, and in 2010, it reached 20.29 percent. According to the most recent data from 2020, 24.23 percent of Cambodia's population lives in urban areas, representing a relative growth of 30 percent between 2000 and 2020.[7]

The surge in urbanisation in Cambodia is not surprising given the well-established link between economic growth and urbanisation, as the country has seen impressive economic progress over the past 20 years (prior to the pandemic), reaching lower-middle-income status in 2015.[8] In light of these findings and the pattern that has emerged over the past few decades, it is critical to understand the effects urbanisation is having on the cities in the region, as well as the progress made in

ASEAN's urban regions. In particular, given the rapid pace of change that technology is causing in every part of society, it is critical to look to the future urban areas: smart cities.

Following a brief summary of Cambodia's urbanisation and technological readiness, the remainder of this chapter tackles the topic of smart cities, defining what one is and delving deeper into the ASEAN environment with a focus on comprehending what has been done thus far with relation to urban areas and assessing the ASEAN Smart Cities Framework presented in 2018.

Cambodia: A "Smart" Overview

Cambodia, primarily through tourism and textile exports, was able to maintain an average growth rate of about 8 percent per year between 1995 and 2017, making it the world's sixth fastest-growing economy.[9] Additionally, the poverty rate dropped from 47.8 percent in 2007 to 13.5 percent in 2014.[10] During the opening ceremony of the 2018 Cambodia Outlook Conference, Cambodian Prime Minister Hun Sen stated its vision to have Cambodia graduate as an upper-middle-income country by 2030 and a high-income country by 2050.[11] Accordingly, the observed urbanisation trend in Cambodia can be expected to continue alongside economic growth.

Figure 2: Urban population vs. GDP per capita in Cambodia, between 1999 and 2016[12]

Urban population vs. GDP per capita, 1999 to 2016

Share of the total population living in urban areas versus gross domestic product (GDP) per capita, measured in 2011 international-$.

1999 ●—●—● 2016

Cambodia

	1999	2016
Y Axis	18.47%	22.58%
X Axis	1,586 2011 int-$	3,251 2011 int-$

Source: OWID based on UN World Urbanization Prospects (2018), Maddison Project Database 2020 (Bolt and van Zanden (2020)) OurWorldInData.org/urbanization · CC BY

Furthermore, this process of urbanization has evolved concurrently with another one: the fourth industrial revolution. The concept of Industry 4.0 was introduced during the 2011 German government initiative, and was defined as an essential strategy to adopt for industrial production in an ever-changing world shaped by the Information Communication Technology (ICT).[13] Industry 4.0 has opened the door to radical changes in many aspects of society, including the industrial, social, and economic spheres, radically changing and disrupting labour

5. Zhao, Pengjun, Yat Yen, Earl Bailey, and Muhammad Tayyab Sohail. 2019. "Analysis of Urban Drivable and Walkable Street Networks of the ASEAN Smart Cities Network." *ISPRS International Journal of Geo-Information* 8 (10): 459. https://doi.org/10.3390/ijgi8100459.

6. Chen, Faan, Jianjun Wang, Jiaorong Wu, Xiaohong Chen, and P. Christopher Zegras. 2017. "Monitoring Road Safety Development at Regional Level: A Case Study in the ASEAN Region." *Accident Analysis & Prevention* 106 (September): 437–49. https://doi.org/10.1016/j.aap.2017.07.016.

7. Ibid.

8. Corrado, Riccardo, Robert E. Flinn, and Patchanee Tungjan. 2019. "Can ICT Help Cambodian Students Become the Solution for Improving Education in the Country?" *Journal of Management, Economics, and Industrial Organization* 3 (2): 1–15. https://doi.org/10.31039/jomeino.2019.3.2.1.

9. The World Bank. 2019. "The World Bank in Cambodia: Overview." Text/HTML. World Bank. 2019. http://www.worldbank.org/en/country/cambodia/overview.

10. Ibid.

11. Corrado, Riccardo, Rady Mok, and Sokoudom Ung. 2021. "Cambodia Digital Economy and Society Policy Framework 2021–2035: An Outlook." *Asian Vision Institute*, AVI Perspective, 10 (2021). https://www.asianvision.org/archives/publications/avi-perspective-issue-2021-no-10-cambodia-digital-economy-and-society-policy-framework-2021-2035-an-outlook.

12. Ibid.

13. Bonilla, Silvia H., Helton R. O. Silva, Marcia Terra da Silva, Rodrigo Franco Gonçalves, and José B. Sacomano. 2018. "Industry 4.0 and Sustainability Implications: A Scenario-Based Analysis of the Impacts and Challenges." *Sustainability* 10 (10): 3740. https://doi.org/10.3390/su10103740.

relations in countries around the world, including developing ones like Cambodia.[14]

Considering this disrupting digital wave didn't spare the Kingdom, the Royal Government of Cambodia (RGC), with the vision to drive and accelerate an inclusive and sustainable post-pandemic growth, introduced in 2021 the Cambodia Digital Economy and Society Policy Framework 2021-2035,[15] with the aim to guide the development and process of digital transformation in the country.[16] This framework laid down the vision to build a Cambodian digital economy and society and to promote digital adoption and transformation in every sector. Additionally, taking into account the importance of education, the Cambodian Ministry of Post and Telecommunication (MPTC) has embarked on several projects with the Ministry of Education, Youth and Sport (MoEYS) to increase and foster digital literacy and knowledge on ICT, including IT applications for business and marketing, cybersecurity, digital payments, tech-preneurship, and IT-related education.[17] The RGC's vision also includes the objective of improving the digital infrastructure and readiness of its growing urban areas, turning a select number of them into "smart cities," and integrating this transformation with the Sustainable Development Goals (SDGs), which embody the UN's mission statement

of "a blueprint to achieve a better and more sustainable future for all by 2030".[18]

But what smart cities exactly are, and where does Cambodia stand regarding the development of smart cities in the country? In this chapter we will offer first an overview of the concept of the smart city, accounting for the different definitions offered in the body of literature. Following the chapter, we will discuss an overview of the important factors to consider when developing smart cities, the current framework adopted by the ASEAN members, and how these important aspects play out in the Cambodian context.

Smart Cities: Let's Better Understand the Concept

As Kong & Woods[19] described, labelling a city as 'smart' requires establishing a series of technocentric, homogeneous, and often unrealistic expectations as to how it should operate. A smart city is not a digitally networked and technological city, rather "it is one in which digital technologies are effectively enmeshed throughout the city's pre-existing social, material, economic and governance infrastructures".[20] In general, a smart city can be defined as an urban environment that makes use of ICT's advantages to enhance the efficiency and performance of regular city operations and the quality of services provided to urban

citizens.[21] The idea behind smart cities is to use modern technologies to transform every aspect of a conventional city into an autonomous object able to perform its operation automatically without substantial external support.[22] Sánchez-Corcuera et al.[23] did a review on smart cities and found a very diversified spectrum of definitions on the "smartness" of a city - listing them in core domains: technology-based, domain-based, system-integration-based, data-based, and architecture-based. Given that the idea of a smart city incorporates ICT, urban planning and development, the creative sector, infrastructure, ecology and environment, and even healthcare,[24] it is extremely difficult, if not impossible, to frame it within a field.[25] All of these sectors, along with others, come together in the ecosystems of smart cities, interact, and produce a limitless amount of potential and applications.[26]

Furthermore, diving deeper in the literature research body, Mohanty et al.[27] summarised

"smart infrastructure, smart governance, smart policies, smart transportation, smart healthcare, smart agriculture, smart education, smart economy, smart environment, smart industry, smart energy and smart feedback mechanisms" as the core aspects of a smart city.

As seen, the smart city paradigm is a very complex and wide ecosystem, involving almost every aspect of our life. But with a smart city environment, there are a long list of different initiatives triggered by the wide range of new opportunities that this context offers. Specifically related to initiatives and activities bounded to a smart city ecosystem, Camero et. Al[28] defined a list of smart-initiatives organised in specific domains with corresponding components. These domains are: smart economy, smart environment, smart governance, smart living, smart mobility, and smart people. Each of the domains, including corresponding components can be seen in table 1.

Table 1: Smart City Domains (Camero & Alba, 2019)

Domain	Component
Smart Economy	Entrepreneurship
	Flexibility of labour market
	Innovation
	Productivity
Smart Environment	Environmental protection
	Pollution
	Sustainable resource management

14. Corrado, Riccardo, Sereyvuth Khat, and Enrico Corrado. 2021. "Business Values and Digitalization in Cambodia 4.0." In *Future of Work,* edited by Thomas Hesketh and Robert Hör, 68–85. Digital Insights 4. Phnom Penh: Konrad-Adenauer-Stiftung, Cambodia. https://www.kas.de/en/web/kambodscha/single-title/-/content/future-of-work-1.

15. Ibid.

16. RGC. 2021. "Roadmap for Recovery of Cambodia Tourism During and Post COVID-19." Royal Government of Cambodia. https://ibccambodia.com/wp-content/uploads/2021/05/Eng_Roadmap_Translation-Final-1.pdf.

17. Corrado, Riccardo, Sereyvuth Khat, and Enrico Corrado. 2021. "Business Values and Digitalization in Cambodia 4.0." In *Future of Work,* edited by Thomas Hesketh and Robert Hör, 68–85. Digital Insights 4. Phnom Penh: Konrad-Adenauer-Stiftung, Cambodia. https://www.kas.de/en/web/kambodscha/single-title/-/content/future-of-work-1.

18. United Nations. 2017. "'Inclusive, Equitable and Quality Education' at the Heart of High-Level UN Event." United Nations Sustainable Development. June 28, 2017. https://www.un.org/sustainabledevelopment/blog/2017/06/inclusive-equitable-and-quality-education-at-the-heart-of-high-level-un-event/.

19. Kong, Lily, and Orlando Woods. 2021. "Scaling Smartness, (de)Provincialising the City? The ASEAN Smart Cities Network and the Translational Politics of Technocratic Regionalism." *Cities* 117 (October): 103326. https://doi.org/10.1016/j.cities.2021.103326.

20. Ibid.

21. Silva, Bhagya Nathali, Murad Khan, and Kijun Han. 2018. "Towards Sustainable Smart Cities: A Review of Trends, Architectures, Components, and Open Challenges in Smart Cities." *Sustainable Cities and Society* 38 (April): 697–713.

22. Ahad, Mohd Abdul, Sara Paiva, Gautami Tripathi, and Noushaba Feroz. 2020. "Enabling Technologies and Sustainable Smart Cities." *Sustainable Cities and Society* 61 (October): 102301. https://doi.org/10.1016/j.scs.2020.102301.

23. Sánchez-Corcuera, Ruben, Adrián Nuñez-Marcos, Jesus Sesma-Solance, Aritz Bilbao-Jayo, Rubén Mulero, Unai Zulaika, Gorka Azkune, and Aitor Almeida. 2019. "Smart Cities Survey: Technologies, Application Domains and Challenges for the Cities of the Future." *International Journal of Distributed Sensor Networks* 15 (6): 1550147719853984. https://doi.org/10.1177/1550147719853984.

24. Cook, Diane J., Glen Duncan, Gina Sprint, and Roschelle L. Fritz. 2018. "Using Smart City Technology to Make Healthcare Smarter." *Proceedings of the IEEE* 106 (4): 708–22. https://doi.org/10.1109/JPROC.2017.2787688.

25. Anthopoulos, Leonidas G. 2015. "Understanding the Smart City Domain: A Literature Review." In *Transforming City Governments for Successful Smart Cities,* edited by Manuel Pedro Rodríguez-Bolívar, 9–21. Public Administration and Information Technology. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-03167-5_2.

26. Ibid.

27. Mohanty, Saraju P., Uma Choppali, and Elias Kougianos. 2016. "Everything You Wanted to Know about Smart Cities: The Internet of Things Is the Backbone." *IEEE Consumer Electronics Magazine* 5 (3): 60–70. https://doi.org/10.1109/MCE.2016.2556879.

28. Camero, Andrés, and Enrique Alba. 2019. "Smart City and Information Technology: A Review." *Cities* 93 (October): 84–94. https://doi.org/10.1016/j.cities.2019.04.014.

Domain	Component
Smart Governance	Participation in decision-making
	Public and social services
	Political strategies and perspectives
Smart Living	Cultural facilities
	Educational facilities
	Health conditions
	Housing quality
	Touristic attractivity
Smart Mobility	Availability of ICT infrastructure
	Accessibility
	Sustainable, innovative, and safe transport systems
Smart People	Creativity and flexibility
	Level of qualification
	Participation in public life
	Open-mindedness
	Social and ethnic plurality

Smart Cities: The ASEAN Context

After this introduction to the general smart city paradigm, let's focus specifically on the ASEAN context. Diving deeper into the smart cities project in the ASEAN ecosystem, the ASEAN members have already outlined their interest in this paradigm, and have placed the smart city concept as a focal point in the region, a decision driven by the rising urbanisation that the region is experiencing.

Driven by a rapid process of urbanisation, ASEAN cities are increasingly confronting challenges that pose a serious threat to sustainable development, across every aspect of the sustainability spectrum, including issues such as congestion, strained infrastructure, pollution, lack of affordable housing, and socio-economic inequality.[29]

The majority of ASEAN's growth has been and will continue to be driven by metropolitan areas, which are anticipated to increase in number over the course of the next ten years, further fueling the region's growth.[30] Thus, considering the current and anticipated growth of this development process, the ASEAN Smart Cities Network (ASCN) was introduced during Singapore's ASEAN Chairmanship in 2018, as one of the priority deliverables for the ASEAN community, while recognising the potential contribution of technologies and innovative solutions with the goal to build resilient and sustainable communities.[31] In reality, the idea of ASCN was initially proposed by the Prime Minister of Singapore at the ASEAN leaders' summit in Singapore in November 2017, and after it, every year the members met in ASCN meetings and workshops hosted each year in a different country.[32] It is not surprising that the idea was initiated by Singapore since Singapore is one of the first countries in ASEAN to have embarked on a Smart Nation Programme (officially started in 2014).[33]

Regarding the ASCN, it was created with three main goals: promoting cooperation

29. CLC. 2018. *ASEAN Smart Cities Network*. Singapore: Centre for Liveable Cities (CLC). https://www.clc.gov.sg/docs/default-source/books/book-asean-smart-cities-network.pdf.

30. Ibid.

31. Ibid.

32. Tan, Si-Ying, Araz Taeihagh, and Kritika Sha. 2021. "How Transboundary Learning Occurs: Case Study of the ASEAN Smart Cities Network (ASCN)." *Sustainability* 13 (11): 6502. https://doi.org/10.3390/su13116502.

33. Ibid.

on smart city development between ASEAN cities, developing commercially viable projects together with private actors, and facilitating collaboration with ASEAN's External Partners.[34] In table 2, it is possible to see an overview of the cities part of the project. For Cambodia, three cities were included: Battambang, Phnom Penh, and Siem Reap.

Table 2: Cities participating in the ASEAN Smart City Network

ASEAN Member	City
Brunei	Bandar Seri-Begawan
Cambodia	Battambang Phnom Penh Siem Reap
Indonesia	Banyuwangi Jakarta Makassar
Laos	Luang Prabang Vientiane
Malaysia	Johor Bahru Kota Kinabalu Kuala Lumpur Kuching
Myanmar	Mandalay Nay Pyi Taw Yangon
Philippines	Cebu Davao Manila
Singapore	Singapore
Thailand	Bangkok Chonburi Phuket
Vietnam	Da Nang Hanoi Ho Chi Minh

34. Ibid.

It is important to highlight as ASEAN is a diverse geographical area, and also the cities involved in the ASCN project have diverse geographies, historical, social, cultural, and economic backgrounds.[35] In fact, as Kong & Woods[36] wrote, "these cities reflect the diversity of the region, and range from provincial cities – such as Banyuwangi and Makassar in Indonesia, and Chonburi in Thailand – to global and regional urban hubs such as Singapore, Bangkok, and Kuala Lumpur". Each of the 26 cities has a Chief Smart City Officer which represents the city in the ASCN, with the role of driving and overseeing the smart and sustainable urbanization, in addition to a National Representative with the duty to assure that the development of the cities is aligned with their respective national directives.[37] This structure has been created in alignment with the vision of the ASCN to provide an innovative approach for enhancing cooperation and partnership between the members of the ASEAN community, focusing on the city-level for delivering more well-tailored and effective change-making solutions.[38] Additionally, the project of smart cities in ASEAN is planned to achieve a balance between three goals: foster a competitive economy, support a sustainable environment and enhance the quality of life.[39]

Accounting for the ASEAN diversity, and for the ASCN, which de facto represents a common framework across the region, what are the main aspects defined by this framework? And, where does specifically Cambodia stand?

35. Zhao, Pengjun, Yat Yen, Earl Bailey, and Muhammad Tayyab Sohail. 2019. "Analysis of Urban Drivable and Walkable Street Networks of the ASEAN Smart Cities Network." *ISPRS International Journal of Geo-Information* 8 (10): 459. https://doi.org/10.3390/ijgi81009.

36. Ibid.

37. Ibid.

38. Ibid.

39. Ibid.

ASEAN Smart Cities Framework: A Cambodian View

The design, construction, and management of any smart city is a complicated process, involving many actors and stakeholders.[40] This process becomes even more complicated in a context like ASEAN, where many cities from a diverse region participate in a common project for developing a smart urban environment across the region. Kong & Woods[41] wrote that "nearly all cities – with Singapore being the notable exception – are implicated in competing levels of governance, and competing interests amongst public- and private-sector stakeholders".

To tackle this non-homogenous ecosystem, Kong & Woods[42] highlighted how ASEAN, to be successful in the smart city projects, requires two typologies of integration, namely a vertical and horizontal integration. Specifically, vertical integration refers to the need for different layers of a government to be aligned, and horizontal integration refers to the need for different governing bodies within the same layer, or for stakeholders from both the public and private sectors, to be aligned.[43]

Figure 3: Integrations required for a successful smart city development
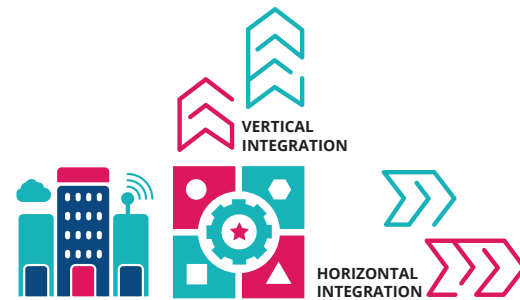
With the goal to drive the development and integration in each member's context of the smart city paradigm, the ASEAN Smart Cities Framework was created, defining four main categories namely Enablers, Development Focus Area, Urban Systems, and Smart City Strategic Outcomes.[44]

ASEAN Smart Cities Framework	
Category	**Components**
Enablers	Digital Infrastructure and Applications
	Partnership and Funding
Development Focus Area	**Civic and Social**
	• Social Cohesion
	• Cultural and Heritage
	• Tourism
	• Public and Municipal Services
	• Governance
	Health and Well-Being
	• Housing and Home
	• Healthcare
	• Education

ASEAN Smart Cities Framework	
Category	**Components**
Development Focus Area	**Safety and Security**
	• Resource Security
	• Cybersecurity
	• Public Safety, City Surveillance and Crime Prevention
	Quality Environment
	• Clean Environment
	• Resource Access and Management
	• Urban Resilience
	Built Infrastructure
	• Utilities
	• Mobility and Transportation
	• Building and Construction
	Industry and Innovation
	• Business and Entrepreneurship
	• Trade and Commerce
	• Upskilling
	• Technology Incubation
	• Research
Urban Systems	Integrated Master Planning and Development
	Dynamic and Adaptive Urban Governance
Smart City Strategic Outcomes	Competitive Economy
	Sustainable Environment
	High Quality of Life

After understanding categories and components defined by the framework, let's dive deeper into each of them, with a specific view on the Cambodian context.

The Enablers

Regarding the first category, namely Enablers, it includes Digital Infrastructure and Applications, and Partnership and Funding. Regarding digital infrastructure and applications, ASCN explained how "smart cities should embrace the opportunities afforded by new technologies and innovation, and adopt solutions with wide-ranging applications in order to maximise benefit optimisation and resource efficiency" (CLC, 2018, p. 16). Examples include geospatial databases to monitor various aspects in the city, urban spatial data information systems, data analytics to support city operations and drive innovation, ICT infrastructure for supporting networking, and e-payments and digital platforms.

Regarding the last point, namely e-payments and digital platforms, Cambodia has seen a sharp rise of digital payments, with the total transaction value in the digital payments segment being projected to reach 3,343m US Dollars in 2022.[45] Additionally, the National Bank of Cambodia (NBC) has introduced several solutions in the last five years. Specifically, in 2016, NBC launched the FAST system as a supplementary payment system to promote electronic payments, a solution that did not address card payment connectivity.[46] To address this challenge, the year after the NBC introduced CSS "a nationwide infrastructure for local debit

40. Ibid.

41. Ibid.

42. Ibid.

43. Ibid.

44. Ibid.

45. Statista. 2022. "Digital Payments - Cambodia." Statista. 2022. https://www.statista.com/outlook/dmo/fintech/digital-payments/cambodia.

46. NBC. 2020. "Project Bakong - Next Generation Payment System." National Bank of Cambodia. https://bakong.nbc.org.kh/download/NBC_BAKONG_White_Paper.pdf.

card payment operated by ATM and POS machines, and a network for international gateway for payment system integration in the region".[47] Additionally, the NBC also initiated Project Bakong. Project Bakong is a wallet-based electronic currency operated on distributed ledger technology, with a public mobile application, with the goal to promote electronic payment and financial inclusion.[48] By unifying banking processes under Bakong, user inclusivity has been boosted, helping to integrate people into the financial system.[49]

But if the digital payment in the country is growing fast, the same cannot be said for the IoT infrastructure, or for satellites, an essential component in the IoT framework. Specifically, regarding the latter, currently, Cambodia is one of the few ASEAN countries without a satellite or a domestic space institute.[50] Sakal et al. (2021) identified two main reasons why the development of space technology in Cambodia is not progressing as fast as other ASEAN countries: first, lack of understanding of how to access space technology and its benefits to the social-economics aspect of Cambodian context, and secondly a lack of experts and researchers in this field who can help raise awareness and foster its growth. Additionally, in the context of Cambodia, there is still a lack of awareness of the value of data to support decision-making. While enterprises are beginning to recognize the advantages of such an approach, they are also mindful that both private and public sectors are not yet prepared for it.[51]

Furthermore, regarding the Cambodian digital infrastructure (one of the enablers identified by ASCN in its ASEAN Smart Cities Framework) the MPTC has initiated many projects, including enhancement of the national optical fibre backbone, improvement of 4G coverage, Digital Government Cooperation Centre, Internet Gateway, Platform for a National Digital Community, monitoring and improvement of the QoS for the telecom providers, and several projects to enhance awareness and IT-related education in the country, with a focus in the remote areas.

Additionally, regarding partnership, founding, and innovation, many institutions, programs, and competitions have risen across the country, with the goal to foster innovation. Examples are AUPP Technology Center, Angkor Social Innovation Park, Techo Startup Center, iDE Cambodia Innovation Lab, Digital Innovation Center of Institute of Digital Research and Innovation of Cambodia Academy of Digital Technology (CADT), Cambodian Angel Investors Network, Khmer Enterprise, SmartStart Young Innovator Program, and KPMG Ideation Challenge – just to name a few. All of them have different natures and structures, but they are serving a similar purpose: to foster innovation and digitalization in the country.

With these premises, it is also important to highlight that if an innovation wave has been initiated in Cambodia, it is also extremely important to understand that the wave can not only be initiated but needs to be sustained. As a result, it is critical to improve the country's educational offerings while better educating Cambodians for a job market that is rapidly changing.

The Development Focus Areas

Besides the enablers already discussed in the previous section, the ASEAN Smart Cities Framework also identified specific development focus areas for smart cities. Specifically, ASCN identified in its ASEAN Smart Cities Framework six different development focus areas, namely civic and society, health and wellbeing, safety and security, quality environment, built infrastructure, and industry and innovation.

Tourism

Focusing on the Cambodian context, an essential aspect to consider is tourism, a sector that has been heavily affected by the recent pandemic. In 2021, the RGC published a Roadmap for the Recovery of Cambodian Tourism During and Post COVID-19. The dolcumnet defined three phases, namely Resilience and Restart, Recovery, and Relaunch.[52] In this document, Prime Minister Hun Sen states that Cambodia has to "know and increase the attractiveness to take advantage of technology for daily livelihood, leadership, study, work and business".[53] It is well known that in 2020, Cambodia's Tourism Sector faced a negative downturn caused by the pandemic. For instance, in the first 9 months of 2020 Cambodia experienced a 74.1 percent decline in tourists, compared to the same period in 2019.[54] But wherever there is a challenge, there is also an opportunity, and the use of ICT can offer an unprecedented tool for this.

In accordance with the World Tourism Organization (UNWTO), regarding ICT in the tourism sector, "some major impacts on the sector as a whole are the development of smart travel facilitation, smart destinations, and a new wave of job profiles".[55] The combination of information communications technologies and urbanisation promotes innovations that enable an enormous amount of data from residents as well as visitors.[56] Cambodian smart cities can leverage this enormous pool of data to increase operational efficiency and improve quality of life.[57] Gretzel & Koo[58] offered a framework for intertwining smart, city, and tourism, in order to shift from smart cities to smart tourism cities. Considering that Cambodia's economy heavily depends on tourism, this is an essential aspect to consider for the Kingdom.

Health

Concerning health and wellbeing, the second development target area listed by ASCN in the ASEAN Smart Cities Framework, the Cambodian health care system has made significant progress in recent years, and it is now on its way to achieving universal health coverage (UHC). Nevertheless, the road ahead is still long, and, as the World Health Organization stated, it is still common for Cambodians who can afford it to seek medical treatment overseas.[59]

47. Ibid.

48. Ibid.

49. Takemiya, Makoto. 2021. "Is Cambodia's Bakong the Future of Digital Currencies?" World Economic Forum. 2021. https://www.weforum.org/agenda/2021/08/cambodias-digital-currency-ishowing-other-central-banks-the-way/.

50. Sakal, Morokot, Riccardo Corrado, and Morokot Cheat. 2021. "Small Satellite: The Key to Access Space Technology for Cambodia." *CD-Center Aide-Mémoire,* Aide-mémoire, 2 (15): 1–9.

51. Ibid.

52. Ibid.

53. Ibid.

54. UNWTO. 2021. "Digital Transformation." World Tourism Organization. UNWTO. 2021. https://www.unwto.org/digital-transformation.

55. Ibid.

56. Andrisano, Oreste, Ilaria Bartolini, Paolo Bellavista, Andrea Boeri, Luciano Bononi, Alberto Borghetti, Armando Brath, et al. 2018. "The Need of Multidisciplinary Approaches and Engineering Tools for the Development and Implementation of the Smart City Paradigm." *Proceedings of the IEEE* 106 (4): 738–60. https://doi.org/10.1109/JPROC.2018.2812836.

57. Gretzel, Ulrike, and Chulmo Koo. 2021. "Smart Tourism Cities: A Duality of Place Where Technology Supports the Convergence of Touristic and Residential Experiences." *Asia Pacific Journal of Tourism Research* 26 (4): 352–64. https://doi.org/10.1080/10941665.2021.1897636.

58. Ibid.

59. WHO. 2015. *The Kingdom of Cambodia Health System Review.* Vol. 2. 5 vols. Health Systems in Transition. Manila: WHO Regional Office for the Western Pacific. http://iris.wpro.who.int/handle/10665.1/11356.

The RGC has placed a specific focus on financing sustainability and on the implementation of major health system initiatives. One such initiative was the successful implementation phase of the Health Equity and Quality Improvement Project (H-EQIP), a project co-financed by the RGC, the World Bank, and several partner agencies.[60] From one side, in accordance with Asante et al.,[61] the current national benefits from health spending are organised in a manner that reflects the need for health service in the public sector and is usually distributed in favour of the poor. On the other hand, private sector benefits, including private clinics, pharmacies, and private hospital outpatient departments, are found to be substantially pro-rich.[62] While the total health expenditure (THE) distribution in the public sector is skewed pro-poor, "the limited funding often allocated for service delivery at the health center level can affect service quality and undermine the overall effort to improve health outcomes under UHC, with 80 percent of THE in Cambodia, being expended on secondary and tertiary care.[63]

In this scenario, the implementation of e-healthcare in smart city planning is an important step to boost UHC in the country while fostering healthcare and wellbeing for Cambodians, addressing the third of the SDGs. In a smart environment, mobile ICT can support health monitoring and intervention at multiple scales ranging from personal data collection to an entire city and beyond.[64] One of the key benefits of e-health incorporated into smart cities, according to Cook et al., is continuous monitoring. This method helps to discover subtle disease symptoms that are otherwise difficult to observe through the study of behavioural patterns.[65] In an ecosystem like Cambodia, where the telecommunication infrastructure is growing fast,[66] and smartphone ownership is widespread with 96 percent of the population in Cambodia owning a mobile phone (not necessarily a smartphone),[67] mobile solutions can be leveraged for enhancing awareness, accessibility, and monitoring individual's health and well-being. On the other hand, it is also important to highlight that smartphone ownership and internet usage are mostly widespread between generations in urban areas,[68] and the overall tech-savviness is relatively low across the country, mostly from those slices of the population that would need e-healthcare solutions the most.

Safety & Security

Furthermore, another development focus area of the framework is represented by human security. Specifically, the human security concept itself is still blurred in Cambodia and the discourse is little used in policies, but human security-related concerns are considered by the RGC to be the highest priority.[69]

The definition of human security is still not clearly defined in the Cambodian context. As Sovachana & Beban[70] highlighted, there is a blurred and complicated equilibrium between the state's goals for economic development and poverty reduction and the impacts of these same development processes for social and environmental justice. In this context, Laufs et al.[71] identified three categories of security interventions in smart cities, each of them with two sub-categories. The first category includes those interventions focusing on the combination of new sensors with traditional actuators, for detecting and preventing unwanted criminal behaviour, identifying, authenticating, and defeating offenders.[72] The second category includes those interventions that aim to transform old systems into smart systems by "either improving/automating processes or by managing and integrating the interplay between existing security solutions".[73] Finally, the last category groups those interventions that rely on new functionalities such as mass information and crowd-sourcing, and threats or crime prediction.[74] During the development of Cambodian smart cities, all these three aspects can be guided, fostered, and exploited for supporting the overall human security throughout the country.

Environmental Protection

But human security is not the only aspect that the smart city framework can foster. Specifically, ICT in the context of a smart city can also support environmental protection. Jamil et al.[75] showed how data collection for pollution monitoring-related processes could be performed using public transportation. A different solution to the same problem was proposed by Toma et al.,[76] deploying sensors on traffic lights. Additionally, an integrated IoT approach with the smart city vision has been discussed in a few papers,[77] but an effective and scalable solution can be deployed only if an initial framework on standards, usage, and standards is initially agreed upon at the national level.[78]

Construction & Urban Planning

Also, the construction sector and the urban planning and urban development sectors are deeply connected to a smart city approach. In the past decades, in fact, the construction sector has shown an increasing interest in using Building Information Modeling (BIM), recognizing the many benefits and resource savings during the design, planning, and construction of new buildings.

60. Hyder, Ziauddin, and Nareth Ly. 2021. "Cambodia: Progressing Toward Universal Health Coverage." World Bank Blogs. 2021. https://blogs.worldbank.org/health/cambodia-progressing-toward-universal-health-coverage.

61. Asante, Augustine D, Por Ir, Bart Jacobs, Limwattananon Supon, Marco Liverani, Andrew Hayen, Stephen Jan, and Virginia Wiseman. 2019. "Who Benefits from Healthcare Spending in Cambodia? Evidence for a Universal Health Coverage Policy." Health Policy and Planning 34 (Supplement_1): i4–13. https://doi.org/10.1093/heapol/czz011.

62. Ibid.

63. Ibid.

64. Cook, Diane J., Glen Duncan, Gina Sprint, and Roschelle L. Fritz. 2018. "Using Smart City Technology to Make Healthcare Smarter." Proceedings of the IEEE 106 (4): 708–22. https://doi.org/10.1109/JPROC.2017.2787688.

65. Ibid.

66. Corrado, Riccardo, and Patchanee Tungjan. 2019. "How Digital Tech Can Help Fix Cambodia's Broken Education and Healthcare Systems." In E-Governance in Cambodia, edited by Christopher Perera and Robert Hör, 20–39. Digital Insights 2. Phnom Penh: Konrad-Adenauer-Stiftung, Cambodia.

67. The ASEAN Secretariat. 2020. ASEAN Sustainable Development Goals Indicators Baseline Report 2020. Jakarta: The ASEAN Secretariat. https://asean.org/storage/2020/10/ASEAN-SDG-Indicator-Baseline-Report-2020.pdf.

68. Ibid.

69. Sovachana, Pou, and Alice Beban. 2019. "Human Security Problems in Cambodia: Far from Over." In Human Security Norms in East Asia, edited by Yoichi Mine, Oscar A. Gómez, and Ako Muto, 23–44. Security, Development and Human Rights in East Asia. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-97247-3_2. Cambodia."

70. Ibid.

71. Laufs, Julian, Hervé Borrion, and Ben Bradford. 2020. "Security and the Smart City: A Systematic Review." Sustainable Cities and Society 55 (April): 102023. https://doi.org/10.1016/j.scs.2020.102023.

72. Ibid.

73. Ibid.

74. Ibid.

75. Jamil, Muhammad Saqib, Muhammad Atif Jamil, Anam Mazhar, Ahsan Ikram, Abdullah Ahmed, and Usman Munawar. 2015. "Smart Environment Monitoring System by Employing Wireless Sensor Networks on Vehicles for Pollution Free Smart Cities." Procedia Engineering, Humanitarian Technology: Science, Systems and Global Impact 2015, HumTech2015, 107 (January): 480–84. https://doi.org/10.1016/j.proeng.2015.06.106.

76. Toma, Cristian, Andrei Alexandru, Marius Popa, and Alin Zamfiroiu. 2019. "IoT Solution for Smart Cities' Pollution Monitoring and the Security Challenges." Sensors 19 (15): 3401. https://doi.org/10.3390/s19153401.

77. Agarwal, Aditya, Vishakha Shukla, Rajesh Singh, Anita Gehlot, and Vikas Garg. 2018. "Design and Development of Air and Water Pollution Quality Monitoring Using IoT and Quadcopter." In Intelligent Communication, Control and Devices, edited by Rajesh Singh, Sushabhan Choudhury, and Anita Gehlot, 485–92. Advances in Intelligent Systems and Computing. Singapore: Springer. https://doi.org/10.1007/978-981-10-5903-2_49.

78. Corrado, Riccardo. 2021. "ICTs and AI-Driven Solutions for Disaster Management." Aide-Mémoire. Phnom Penh, Cambodia: CD-Center. https://cd-center.org/2021/07/06/khmer-icts-and-ai-driven-solutions-for-disaster-management/.

Regarding this, in fact, Borrmann et al.[79] showed how digital workflows in the project information management speed up the process compared to a conventional workflow, due to the smoother transition of phases, from conceptual design to detailed design, construction, and operations. BIM can increase revenue, support safety control, and facilitate integration with technology.[80] Additionally, big data applied to the urban context (UBD) can facilitate planning, designing, and maintenance of smart cities, thus enabling big data analytics to manage and process voluminous urban big data to enhance the quality of urban services.

Data can in fact be collected from numerous neighbourhoods to gain a better holistic understanding of the urban fabric.[81] In this regard, frameworks can play a fundamental role in facilitating the process, mostly when dealing with the IoT and big data, solutions that have the ability to offer smart cities the ability to enhance their efficiency and responsiveness.[82]

On the other hand, it is also fundamental to consider the privacy and cyber security aspect of such solutions,[83] and in this context, it is essential to remember that access to data must be carefully sought as privacy is considered a fundamental human right in many democracies.[84] At this stage, IoT infrastructure in Cambodia is still lacking or absent, and there is still a clear misunderstanding of BIM implementation in the construction sector, with BIM seen as a simple software to use rather than a changing paradigm in the sector itself.

Industry & Innovation

Finally, the last category of Development Focus Area in the ASEAN Smart City Framework is represented by Industry and Innovation. Science, Technology, and Innovation (STI) represent the fuel for the development of Cambodia. The Cambodian technology start-up ecosystem has progressed rapidly, with currently over 300 active technology start-ups operating.[85] Also, private support is on the rise with more co-working spaces, incubators, local angel investors, private equity, and venture capital funds appearing in the Cambodian market.[86] Accounting for the need to guide and drive this growth, in 2019 the Prime Minister of Cambodia approved the National Science, Technology and Innovation Policy 2020-2030, a framework focusing on strengthening the national STI foundation and nurturing an innovation ecosystem that is conducive to sustainable and inclusive development.[87] In 2020, the RGC officially changed the name of Ministry of Industry and Handicraft to the Ministry of Science, Technology, and Innovation (MISTI), instructing the ministry to "support and make it possible

for the new units to meet practical needs of relevant institutions so the sectors of scientific and technological research and innovation will improve within the context of the Fourth Industrial Revolution".[88] MISTI was specifically established to "lead and coordinate STI initiatives that further develop national capacities in this area, support key stakeholders and create favourable framework conditions".[89] Nonetheless, the collaboration between stakeholders is essential, since the government by itself cannot be the only player to move the country away from its low position (101st position out of 127 countries) in the 2018 Global Innovation Index.[90] In accordance with 'The Science, Technology and Innovation Ecosystem of Cambodia',[91] five policy strategies were suggested for being considered by policymakers: i) enhance the governance structure of the STI system, ii) develop the national STI workforce, iii) strengthen research capacity and quality, iv) increase collaboration and linkages between different actors, and v) foster an enabling environment for innovation. Cambodia is moving fast, but "it is essential to focus on the sustainability of this latest wave of innovation and entrepreneurialism, so that its momentum can continue for years to come.

Conclusions

Cambodia has made significant progress in recent years, and the smart city project serves as a roadmap for the country's ambition to not only participate in the global digitalization wave of investment but

also to actively use technology to advance sustainable development. In 2018 Cambodia took part in the ASEAN Smart Cities Network, which introduced the ASEAN Smart City Framework to guide the development of the cities that are participating in the project.

For Cambodia, currently, there are three cities participating in the project: Battambang, Phnom Penh, and Siem Reap. This chapter offered an overview of two categories identified in the framework, namely enablers and development focus areas, offering an in-depth discussion of each of them, tailored specifically to the Cambodian context. Each of the six different development focus areas proposed in the framework, namely civic and society, health and wellbeing, safety and security, quality environment, built infrastructure, and industry and innovation has been discussed offering a clear depiction of the state of the art for the Kingdom. The chapter also offered an overview of the many initiatives that the RGC has started to support the growth of the country, and that are in alignment with the ASEAN Smart City Framework as well.

In summary, Cambodia is moving fast, yet the road ahead is long, and a national roadmap should be considered, accounting for what has been done already and for the goal and vision ahead for Cambodia's smart cities. The ASEAN Smart City Framework, in fact, can not be seen as a ready-to-use framework for each national context, but it must be customised in accordance with each ecosystem. Additionally, another aspect mentioned in the chapter is the importance of horizontal and vertical integration, an essential aspect for the smart city project to be successful in any context. The road ahead is long and with many challenges, but as a famous quote says, only those who dare to fail greatly can ever achieve greatly.

79. Borrmann, André, Markus König, Christian Koch, and Jakob Beetz. 2018. "Building Information Modeling: Why? What? How?" In *Building Information Modeling: Technology Foundations and Industry Practice,* edited by André Borrmann, Markus König, Christian Koch, and Jakob Beetz, 1–24. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-92862-3_1.

80. Costin, Aaron, Alireza Adibfar, Hanjin Hu, and Stuart S. Chen. 2018. "Building Information Modeling (BIM) for Transportation Infrastructure – Literature Review, Applications, Challenges, and Recommendations." *Automation in Construction* 94 (October): 257–81. https://doi.org/10.1016/j.autcon.2018.07.001.

81. Allam, Zaheer, and Zaynah A. Dhunny. 2019. "On Big Data, Artificial Intelligence and Smart Cities." Cities 89 (June): 80–91. https://doi.org/10.1016/j.cities.2019.01.032.

82. Mohanty, Saraju P., Uma Choppali, and Elias Kougianos. 2016. "Everything You Wanted to Know about Smart Cities: The Internet of Things Is the Backbone." *IEEE Consumer Electronics Magazine* 5 (3): 60–70. https://doi.org/10.1109/MCE.2016.2556879.

83. Allam, Zaheer, and Zaynah A. Dhunny. 2019. "On Big Data, Artificial Intelligence and Smart Cities." *Cities* 89 (June): 80–91.

https://doi.org/10.1016/j.cities.2019.01.032.

84. Diggelmann, Oliver, and Maria Nicole Cleis. 2014. "How the Right to Privacy Became a Human Right." *Human Rights Law Review* 14 (3): 441–58. https://doi.org/10.1093/hrlr/ngu014.

85. UN ESCAP. 2021. "The Science, Technology and Innovation Ecosystem of Cambodia." 2021. https://artnet.unescap.org/sti/publications/books-reports/science-technology-and-innovation-ecosystem-cambodia.

86. Ibid.

87. Ibid.

88. Koemsoeun, Soth. 2020. "Ministry Changes Its Name, Scope of Operations." The Phnom Pehn Post. 2020. https://www.phnompenhpost.com/national/ministry-changes-its-name-scope-operations.

89. Ibid.

90. Ibid.

91. Ibid.

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ASEAN SMART CITIES NETWORK (ASCN): The Case of the Hanoi Pilot Project and Implications for the Cambodia, Laos, Myanmar (CLM) Sub-Region

CHHAY LIM   PHANITH VUN

Background

In recent years, the five mega-cities, four large cities, 20 medium-sized cities, and 21 small cities in the Association of Southeast Asian Nations (ASEAN) have been responsible for the increase in middle-class households in the region from just 38 million in 2015, to over 161 million in 2030.[1] Despite the business and investment opportunities brought by rapid urbanization, ASEAN is struggling to deal with the effects of this phenomenon, including pollution, city congestion, urban poverty, income disparity, etc.[2] Given the contribution of ASEAN smart urbanization to the ASEAN Community, Singapore took the lead in establishing the ASEAN Smart Cities Network (ASCN) during its ASEAN Chairmanship in April 2018. The ASCN expects to serve as a collaborative platform where three pilot cities from each ASEAN Member state (AMS) are critically selective to include in the development process towards innovative and sustainable urbanization within the ASEAN Smart Cities projects.[3] In this regard, Chief Smart City Officers of 26 pilot cities with their National Representatives from AMS need to be chosen and appointed to work together to achieve the goal. In the capacity to bridge the development gap between the bloc members, ASEAN will strive to improve the pilot cities concerning under-developed plans and seek financial and technical support from its dialogue partners to complement the ASCN's initiative, despite the growing challenges of global issues.[4] In this essence, the goals of ASCN include: making sure that people from ASEAN can benefit from technology capacity sharing among AMS, including support from ASEAN external partners, to develop the cities with an inclusive approach in which human rights and fundamental freedoms of the people are respected and maintained, lastly to enhance ASEAN cultural identity through ASCN development projects.

As this paper is scoped to the Cambodia, Laos, Myanmar, Vietnam (CLMV) sub-region, it focuses on the Hanoi Pilot project, specifically, as the main case to analyze the existing policy of Vietnam, as well as to review the connection between the Hanoi city project and the fast-economic growth of Vietnam. With that being said, the second part of the paper is to look at whether Hanoi can play a modeling role for CLM countries, where economic development is relatively lower than the other AMS. Also, it thoroughly examines the current developments of ASCN in CLM countries. It then explores the roles of ASEAN external partners in promoting and supporting ASCN in CLMV countries, including the challenges to the development of ASCN. Since ASCN remains a new concept for AMS to follow with Singapore's proposal, all AMS policies to develop pilot cities under the ASEAN Smart Cities Framework are still ambiguous. Thus, this paper seeks to provide policy recommendations to improve ASCN, especially in CLM countries.

Current Development of ASEAN Smart Cities Network in the CLM Countries

Cambodia

Phnom Penh Capital, Siem Reap, and Battambang Province were selected to participate in the ASEAN Smart Cities Network. From a Cambodian perspective, as expressed by the Cambodian Minister

1. "ASEAN cities struggling to manage effects of urbanization," Brink News, October 11, 2016, https://www.brinknews.com/asean-cities-struggling-to-manage-effects-of-urbanization/

2. Ibid.

3. "Concept Note of the ASEAN Smart Cities Network," ASEAN, accessed April 29, 2022, https://asean.org/concept-note-of-the-asean-smart-cities-network/

4. "ASEAN Smart Cities Network," ASEAN, accessed April 29, 2022, https://asean.org/our-communities/asean-smart-cities-network/

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of Civil Services, the smart city is a project aiming at the integration of digital advances and livability, and with a need to focus on jobs, food, transportation, communication, education, healthcare, security, electricity, and clean water.[5] Therefore, the three cities have special features and different focuses on city planning. Phnom Penh's action plan centers on improving the environment and people's quality of life. Siem Reap is Cambodia's largest city of cultural heritage and therefore aims to attract more tourist destinations and conserve the cultural identity, while Battambang's focus is to boost social responsibility and a clean environment.[6]

The current ASCN partnership in Cambodia includes (1) ING Holdings Cambodia, Causeway Bay Group HK, and Sino Bay Construction HK, focusing mainly on Phnom Penh's industry and innovation (2) Cambodia's Ministry of Land Management, Urban Planning, and Construction with Korea's Ministry of Land, Infrastructure and Transport on ICT for City Planning. (3) Cambodia's Ministry of Land Management, Urban Planning and Construction with Japan's Ministry of Land, Infrastructure, Transport and Tourism.[7]

The Smart City concept is still relatively immature in Cambodia's context due to some significant challenges like the utility of technology, attitude, and willingness of the citizens (digital literacy), as well as the lack of clear implementation steps by urban

planning experts. This year Phnom Penh City Hall can roll out the five strategic roadmaps to transform five areas: land use, safety and security, urban mobility, environment, and digital management.[8]

Laos

Laos has placed its two cities as the concerted plan for smart city development, namely Vientiane and Luang Prabang.

Serving as the potential city of Lao PDR, the development of Vientiane city has faced several challenges, as the government aims to adapt to a fast-changing geopolitical landscape. In 2018, Laos proposed two critical projects for promoting innovative city development in the Vientiane capital. The two projects are named (1) the Establishment of Drainage System and (2) the Sustainable Transport Plan, which are needed to create a solution to water-related issues, including pollution and flooding. The Ministry of Land, Infrastructure, and Transport (MOLIT) has supported the Project on the Establishment of Drainage system in Laos, including the feasibility study and creation of a preliminary master plan.[9] In this sense, the government of South Korea has shared Korean development experiences on a smart city to provide Vientiane's authority to address issues on urban development. In 2019, having spent years studying the concept of a smart city in Laos, the government has transformed it into Laos's smart city work plan, focusing on economic promotion and foreign investment.

In mid-2020, the Prime Minister of Lao PDR authorized the permission for Douangchaleun Development Construction Group, a Lao-own construction company, focusing on two central districts named Saysettha and Hatxayfong and covering the 2,900 hectares of land.[10] The Laos government has thus prioritized the development of smart cities by seeking support from domestic and international funds.

In July 2021, the Study Project for Smart City Development in Vientiane city was conducted under a Japanese-funded scheme to tackle infrastructure challenges, to improve the living standards of Laotian citizens, and to improve the efficiency of government operations.[11] Simultaneously, another Japanese funded project is also underway, called the "Smart City Planning Development Targets: Luang Prabang: City. This project aims to improve the quality and efficiency of city services, and improve city governance and operations.

Myanmar

Myanmar takes in Nay Pyi Taw, Yangon, and Mandalay as the members of ASCN. Starting a bit earlier than ASCN's establishment, Myanmar created the Digital Economy Development Committee to transform the country into a digital, knowledge, and innovation hub. As the capital city, Nay Pyi Taw prioritizes a clean city, healthcare system, transportation, electricity, and education. To develop a smart city, Nay Pyi Taw has focused only on three points: (1) Smart Street Lighting project, (2)

E-government and utility of ICT in public services, and (3) Geographic Information System (GIS) for the government to map the electricity supply and crowd movement. Yangon is currently the largest city, home to a population of 5.2 million, and accounts for 20 percent of the country's GDP.[12] Yangon has not focused much on applying science and technology in city planning and infrastructure besides its aim for a flood detection system, 3D city-mapping and zoning system, and the online permit and payment application.[13] Mandalay announced their smart city initiative in 2017 to focus on only traffic management, utilization of social media for people-government communication, fleet management system as part of waste management, and AI-powered surveillance to monitor crimes.[14]

Unfortunately, the socio-economic development of Myanmar has been in stagnation, to a certain extent, for over one year due to the coup by the Tatmadaw military group in February 2021. With political instability and disruption of economic activities by the COVID-19 pandemic, the urbanization development projects in Myanmar have been suspended, thus slowing down the progress of its smart city plan.

Case of Vietnam: The Hanoi Pilot Project

In a general view, Vietnam's urbanization increased from 25 percent to 35 percent in the last twenty years. Vietnam's cities have experienced significant challenges regarding transport systems, people mobility, disparity of economic opportunities, and the quality of

5. "Cambodia to develop smart cities for increased tourism and living standards," Asia Property Award, July 14, 2021, https://www.asiapropertyawards.com/en/cambodia-government-discuss-plans-on-developing-smart-cities-for-tourism-and-living/

6. "Cambodia to develop smart cities for increased tourism and living standards," Asia Property Award, July 14, 2021, https://www.asiapropertyawards.com/en/cambodia-government-discuss-plans-on-developing-smart-cities-for-tourism-and-living/

7. Melinda Martinus, "ASEAN Smart Cities Network: A Catalyst for Partnerships," April 21, 2020, (ISEAS Yusof Ishak Institute), Perspective, no 32 (2020), http://hdl.handle.net/11540/11853.

8. "City Hall outlines 5 strategic roadmaps to transform Phnom Penh into smart city," Construction and Property, February 18, 2021, https://construction-property.com/city-hall-outlines-5-strategic-roadmaps-to-transform-phnom-penh-into-smart-city/

9. "MOLIT announces 12 projects for K-City Network Global Cooperation Program," Ministry of Land Infrastructure and Transport, April 20, 2020, http://www.molit.go.kr/english/USR/BORD0201/m_28286/DTL.jsp?

10. Phayboune Thanabouasy, "Local Company to Construct Smart City in Vientiane Capital," November 16, 2021, https://laotiantimes.com/2021/11/16/local-company-to-construct-smart-city-in-vientiane-capital/

11. "Study Project for Smart City Development in Vientiane Capital," Mekong Consultant, October 2021, https://www.mekongconsultants.com.la/Project/study-project-for-smart-city-development-in-vientiane-capital-city/

12. "Smart City in Myanmar: opportunities and challenges," Asia IoT Business Platform, September 23, 2019, https://iotbusiness-platform.com/insights/smart-city-in-myanmar-opportunities-and-challenges/

13. Ibid.

14. Ibid.

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life.[15] Vietnam has been very active in pushing the smart cities project, following the action plans and concept note of ASCN established in 2018. For more than 35 years after implementing the Doi Moi Policy (renewal policy), the urbanization development of Vietnam has primarily contributed to GDP growth and their competitive economy. Vietnam applies science and technology in urban management and development and also creates a vital information infrastructure and efficient e-government to ensure people's comprehensive development and sustainable urban ecology.[16]

Specifically, in the case of Hanoi, it is very interesting to see the city's planning aligned with the concepts of ASCN. Hanoi is recently moving forward as a smart and sustainable city through its focused features on energy, transport, communities, education, healthcare, and economies.[17] Looking into these project features, we can see that Hanoi applies the concepts of the ASCN framework, which itself comprises three main categories on the strategic level: competitive economy, sustainable environment, and high quality of life.

Japan and Singapore remain the top two foreign investors in Hanoi in terms of external partners. Currently, the largest Project is called the "Smart City Project," located in the northern area of Hanoi, under the investment of Vietnam's BRG Group and the cooperation of Japan's Sumitomo Corporation.[18] Starting in 2019, the "Smart

City Project" will project a future of Hanoi as the main focal point for the space and architecture of the city's gateway, adding to the values of urbanization in the northern Red River area and overall contributing to Vietnam's socio-economic development.[19] It is worth noting that the project is worth USD 4.2 billion and covers the land of 272 hectares. The main focuses would be:

- Creating a multifunctional smart monitoring and warning system to keep air and water quality, weather, and natural disasters risks security and safety.

- Prioritizing a system of smart buildings and renewable energy technology to optimize energy supply and storage.

- Implementing an environmentally-friendly public transport system.

- Realizing Vietnam's Vision 2030 and 2018-2025 commitment to establishing a chain of smart cities in the north, central, south, and the Mekong Delta.[20]

Singapore remains the second largest investor in Hanoi, just behind Japan. There are currently 434 projects supported by Singaporean investment ongoing, worth USD 7.43 billion. It is clear that Hanoi is actively benefiting from the support and experience of Singapore as the initiator of the ASCN.[21] The establishment of the Vietnam-Singapore Industrial Park makes Singapore one of the country's largest investors, specifically in Hanoi. The obvious benefit of this is to learn

from Singapore as the initiator of smart cities projects in Southeast Asia through technology and knowledge transfer, or even the technical and financial support.

In short, the following points are what we can learn from the smart city's development in Hanoi. First, the public-private partnership model is boosted by engaging the external partner's investment in the cities. These include creating a business-friendly environment to attract investors and solutions providers. The business space should be prioritized more on the creation of industrial parks, digital and physical infrastructure development, as well as the application of innovative approaches, science, and technology in solving critical urban issues. Second, promoting smart city dialogues through best practices and knowledge exchange on smart city development. Lastly, smart city planning should be in a broader focus but not limited to only a few areas of the cities. It should also be contextualized and, most importantly, people-centered.

ASEAN External Partners in Promoting and Supporting ASEAN Smart Cities Network in the CLMV Countries

In the roles of ASEAN External Partners, contributions to the development of ASCN vary from one country to another, starting from technical assistance to financial support. However, such supports from ASEAN dialogue partners are still limited, raising more doubt about the level of support to the ASEAN Member States (AMS). In this sense, Cambodia, Laos, Myanmar, and Vietnam (CLMV), whose economic scales of these countries are relatively lower than the maritime ASEAN states, have remained

skeptical of how large they have received support from the dialogue partners.

How has the ASCN Encouraged Dialogue Partners to Stay Committed to Assisting Improved ASEAN Connectivity?

The critical collaborators for ASCN include the US, Australia, Japan, South Korea, and China, contributing variously to developing ASEAN industrialization, mainly providing technical and financial assistance to the CLMV countries. Receiving massive support and promotion at the 13th East Asia Summit (EAS) in November 2018, ASCN is seen as a crucial regional initiative and has been embraced by the leaders of ASEAN, the US, Australia, Japan, China, New Zealand, South Korea, as well as Russia.[22] Such support from ASEAN's external partners has proven crucial to smart urbanisation efforts. It has also become a point of competition, with external partners competing for influence by engaging with ASEAN's connectivity and economic cooperation programs.

During the ASEAN-US summit in 2018, the former vice president of the US, Mike Pence, expressed the US's support for ASCN and pledged to offer a USD 10 million investment budget to ASCN. The fund goes to the regional cybersecurity capacity-building area, mainly through sharing best practices to improve the digital economy and infrastructures within the ASEAN pilot cities.[23] With such initial cooperation, the US-ASEAN Smart City Partnership (USASCP) was launched in 2018 to focus on (1) promoting the US private sector engagement for capacity advancement in ASEAN through innovative city delivery solutions, (2) sharing

15. Brice Richard, "Driving the New Economy: How Smart Cities Are Preparing Vietnam for the Future," ARUP, https://www.arup.com/perspectives/driving-the-new-economy-how-smart-cities-are-preparing-vietnam-for-the-future

16. "Vietnam: ASEAN Smart Cities is the way forward to the future," The Star, October 24, 2020, https://www.thestar.com.my/aseanplus/aseanplus-news/2020/10/24/vietnam-asean-smart-cities-is-the-way-forward-to-the-future

17. "Smart city," BRG Group, https://brggroup.vn/smart-city-da65

18. "Hanoi moves to speed up smart city project," Vietnam Plus, March 24, 2022, https://en.vietnamplus.vn/hanoi-moves-to-speed-up-smart-city-project/223990.vnp

19. "Hanoi moves to speed up smart city project," Vietnam Plus, March 24, 2022, https://en.vietnamplus.vn/hanoi-moves-to-speed-up-smart-city-project/223990.vnp

20. "Ground breaking ceremony for first smart city project in Hanoi," Vietnam Plus, October 06, 2019, https://en.vietnamplus.vn/groundbreaking-ceremony-for-first-smart-city-project-in-hanoi/161615.vnp

21. "Hanoi seeks Singapore's support in smart city development," Hanoi Times, June 22, 2021, https://en.vietnamplus.vn/groundbreaking-ceremony-for-first-smart-city-project-in-hanoi/161615.vnp

22. Matinus, "ASEAN Smart Cities Network: A Catalyst for Partnerships," 3.

23. Ibid.

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best practices of the US technologies, experts, professionals to AMS regarding modern cities, and (3) reinforce cooperation on digital economy and cybersecurity capacity with AMS. Under the USASCP framework, the US, including its department agencies, has been able to create more than 20 projects to improve infrastructures, water and resource management, and the ASEAN pilot cities' transportation-related sectors, including supporting the CLMV countries to solve issues from urbanization.[24] For instance, Ho Chi Minh City has been chosen and paired with San Francisco of California to improve water capacity access to secure efficient urban water service.[25] In Cambodia, city pairs in transportation have been hosted to share knowledge in smart transportation solutions, including forming policy, planning, and technology assessment between Phnom Penh City and Boston City. However, those amounts from the US, particularly to the CLMV countries, remain small, proving that the smaller ASEAN countries, such as Lao PDR, have fewer collaborations, particularly compared to maritime ASEAN states. For the Indo-Pacific region cooperation, most American technical assistance has flown to the main cities of the Philippines, Indonesia, Malaysia, and Thailand. Japan may replace the US's role in pushing the development of the ASEAN pilot cities through ASCN.

Since 2012, Japan has promoted cooperation politically and economically with AMS, starting with infrastructure and human resources development support by using the Free and Open Indo-pacific strategy as the main driving force. In this context, the CLMV countries have received a lot of financial and technical contributions from

Japanese engagement in Southeast Asia, which is in line with Abe's strategic vision of promoting "Quality of Infrastructure" globally. In 2019, the Japan Association for Smart Cities in ASEAN (JASCA) was created to share best practices from Japan and promote collaborations between Japanese private and public sectors with ASEAN ones.[26] In 2019, the first ASEAN-Japan Smart City Network High-Level Meeting was held in Yokohama with participation from the Japanese and ASEAN-related Ministries to discuss many concerns on ASEAN smart cities.[27] At the ASEAN-Japan summit in 2020, the leader of Japan proposed having the Japan-ASEAN Connectivity Initiative, aiming to boost cooperation on connectivity in ASEAN through infrastructure development projects, including strengthening land, sea, and air corridor cooperation.[28] In support of the ASEAN Outlook on the Indo-Pacific (AOIP), ASEAN has received a Japanese development fund of more than USD 655 million for projects.

For instance, in the Battambang province of Cambodia, Japan and Cambodia have undertaken a feasibility study to identify challenges within this province. The results show that the city province needs a safe and clean environment, a better promenade along the Sangsal river, and good waste management, which can generate economic growth and improve the living conditions of people there.[29] Thus, projects related to these challenges are significant for smart city solutions in Battambang province. Similarly,

for the Hanoi case, Japan has conducted a study and identified the key challenges, including overloaded motorcycle congestion in urban areas, making Vietnamese citizens suffer mentally from traffic, accidents, and air pollution.

In addition, Japan has announced Tokyo's yen contribution worth USD 2 trillion for infrastructure and capacity-building projects for individual ASEAN states for the next three years.[30] Japan conducted the project-related development of Mandalay port, Dawei Deep Sea Port Project, the Project for Capacity Development of Road and Bridge Operation and Maintenance, and the Project for Improving Public Bus Service in Yangon and so on. For Laos, the Japanese loan and grant have supported the Project for technical Support on Continuous Improvement of Wattay Vientiane International Airport and the Project of Strengthening Capacity for Maintenance of Roads and Bridges.[31] In this sense, Japanese assistance for ASEAN connectivity projects is beneficial to improving the ASEAN pilot cities, making Japan the critical influencer in ASEAN.

How Does China Contribute to ASCN?

ASEAN and China decided to establish the statement on the Smart City Cooperation Initiatives at the 22nd ASEAN-China Summit in 2019 in Bangkok, displaying Chinese commitment to assisting AMS in solving challenges by cities development. ASEAN and China reaffirmed their commitment to deepen cooperation through sharing best practices of mutual experts, exploring cooperation on standards through related international assessment schemes, conducting joint research for

capacity building in technology, promoting collaborations among private sectors of both sides through information sharing, reinforcing the ASEAN sectoral platforms in the purpose of promoting ASCN and the ASEAN Sustainable Urbanization Strategy, and establishing city partnerships between the ASEAN pilot cities and Chinese cities.[32]

Beijing aims to push its Belt and Road Initiatives (BRI) and target its strong allies, including Cambodia, Laos, and Myanmar. Cambodia is the country that has received Chinese financial support in constructing infrastructures, including roads, bridges, and international airports. At the same time, the China-Laos railway was built to stimulate Laos' economy to be more competitive in the region.[33] Chinese aid also goes to Myanmar to construct various infrastructures, including railways, ports, and power sectors, making Burmese citizens benefit from Chinese investment projects.[34] More importantly, China and Myanmar have established several collaborative platforms, including the China-Myanmar Economic Corridor Forum, which allows China to promote its BRI projects through the corridor starting from China's Yunnan province to Mandalay and Yangon province of Myanmar.[35] Vietnam has become a far-reaching industrialized country, and support from China has been made through the development of Vietnamese high-speed railways and highways in Hanoi. Funded by

24. Fact sheet, "U.S.-ASEAN Smart Cities Partnership (USASCAP): Sharing Expertise Between Cities to Benefit the People of ASEAN," February 12, 2021, https://www.state.gov/u-s-asean-smart-cities-partnership-usascp-sharing-expertise-between-cities-to-benefit-the-people-of-asean/.

25. Ibid

26. Yokota Masafumi, "Japan's support for smart city development in ASEAN- Progress of smart JAMP and guidebook," Ministry of Land, Infrastructure, Transport and Tourism, October 18, 2021, http://ascnjapan2021.jp/eng/dl/document/yokota.pdf.

27. Heather Atherton, "The U.S.-ASEAN Smart Cities Partnership," https://www.usascp.org/home-page.

28. MOFA Japan, "Progress Report on Japan's Cooperation for the ASEAN Outlook on the Indo-Pacific," October 2021, https://www.mofa.go.jp/files/100253488.pdf.

29. Ibid.

30. MOFA Japan, "Japan-ASEAN Connectivity Initiative," November 2020, https://www.mofa.go.jp/files/100114591.pdf

31. Ibid.

32. ASEAN, "ASEAN-China Leaders' Statement on Smart City Cooperation Initiative," November 3, 2019, https://asean.org/asean-china-leaders-statement-on-smart-city-cooperation-initiative/.

33. Xinhua, "China-Laos railway to boot economic development in Laos: official," November 11, 2021, http://en.qstheory.cn/2021-11/30/c_685876.htm.

34. Dipanjan Roy Chaudhury, "Myanmar cozies up to China with infrastructure overtures," The Economic Times, December 25, 2021, https://economictimes.indiatimes.com/news/international/world-news/myanmar-cozies-up-to-china-with-infrastructure-overtures/articleshow/88484303.cms

35. Jiang Zhida, "Belt and Road boosting Myanmar development," China Daily, January 14, 2020, https://global.chinadaily.com.cn/a/202001/14/WS5e1cf966a310128217270a0b.html.

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the BRI framework, Vietnam has boosted its economy, mainly through the recent complete construction of the China-added Cat Linh-Ha Dong metro line project in Hanoi, with the capacity to transport over one million passengers per day.[36]

Following up on the U.S., Japan, and China's engagement in ASCN, Australia and South Korea also expressed their strong commitment to pushing the development of ASEAN smart urbanization beyond traditional engagement in trade and economic cooperation. In this sense, Australia promised to offer a 20 million AUD budget to establish the ASEAN-Australia Smart Cities Trust Fund to address challenges arising from ASEAN's urbanization projects and develop the master plan of digital solutions in ASCN.[37] South Korea has promoted ASCN as its discussion agenda under the ASEAN-the Republic of Korea (ROK) commemorative summit in Busan in 2019, emphasizing ROK's collaboration in ASEAN smart cities, digital economy, and cybersecurity. Developing Smart Cities in ASEAN has significantly aligned with ROK-initiated New Southern Policy.

In short, ASCN has been the significant driving force to keep up smart city development in the AMS, particularly in the CLMV countries. Internally, the AMS have supported each other by sharing best practices, capacity building, digital economic advancement, urbanization solutions, and technical assistance. Externally, engagement from ASEAN dialogue partners has been vital in pushing development in fast unexpectedness. Most of the infrastructures

in the CLMV countries nowadays come from Japanese and Chinese investments, despite some critics of the Chinese development style.

Challenges of ASCN in the CLMV Countries

The common multidimensional challenges for ASEAN smart cities contain waste control, pollution, congestion, fragile financial and physical infrastructures, and climate changes, impacting people's living conditions and quality of life.[38] More importantly, it is true that ASEAN is a diverse region where political, economic, social, cultural, and religious practices are far concerned, making ASEAN awkward to have a common value to deal with the process of urbanization. The lack of joint systematic assessment of smart cities challenges and weak institutional bodies in some AMS has remained problematic that needs to be continuously improved. These issues pose difficulties for ASEAN, mainly the CLMV countries, to address alone.

For example, the Cambodian city of Battambang faces several challenges, such as the unsafe and unclean environment, a ruined promenade along the Sangal River, and poor waste management.[39] The Japanese feasibility study results have come with several project proposals to improve the situation through city centre renewal, a logistics center, and waste management projects. For Laos, Luang Prabang province needs to repair its sewage treatment system by getting support from donors. This issue

can cause environmental pollution to water, air, and land if there is no solution. Thus, Laos needs to work closely with experts from other AMS and dialogue partners to improve the situation.

For Myanmar, the urban challenges in Yangon consist of flooding, traffic jam, utility management, and heritage conservations, which has posed concerns for Myanmar to develop its smart cities in comparison to other AMS.[40] Mandalay, the second-largest city in Myanmar, has faced digital communicative technology with transparency, traffic congestion, and a lack of an AI-powered surveillance system to cope with domestic crimes.[41] Another issue comes from the Mandalay City Development Committee (MCDC) enforcing rules and regulations, despite having a public compliance monitoring system.[42] Hence, handling these issues is essential for Myanmar to develop its pilot cities with support from other AMS and ASEAN external partners. Myanmar should consider establishing a check and balance body to monitor and assess the implementation of the cities' infrastructure projects and reduce corruption as much as possible.

The Vietnamese population has kept increasing from year to year, and physical infrastructures need to be further developed to meet the size of its people. Therefore, Hanoi needs public transportation projects that are of utmost significance to reduce traffic jams, road incidents, and air pollution.[43] If Vietnam can solve all the

above issues, the city will become one of high growth potential in the region, making its citizens lives more comfortable and its market more competitive as an investment destination.

Conclusion and Recommendations

In short, the development of the ASEAN smart cities has produced both opportunities and challenges simultaneously. However, ASEAN needs to accelerate its journey to the digital economy era and obtain the advantages of Industry 4.0. The engagement from ASEAN dialogue partners in promoting and supporting ASCN is crucial for the regional bloc to better off and expand ASEAN's central role in the region and the world. The suggestions for ASEAN, especially for the development of smart cities, are as follows:

1. Continue sharing best practices, knowledge, resources, and cooperation on urban solutions among AMS.

2. Expand cooperation with dialogue partners, especially Japan, China, and the US, to improve and develop ASEAN infrastructures with quality and transparency-based systems. CLMV countries need to speed up this approach.

3. Keep up ASEAN's unity and centrality to make ASEAN a regional bloc for inclusiveness, competitiveness, and cohesiveness in the region and the rest of the world.

36. Xinhua, "China-built urban railway in Vietnam officially inaugurated, transports 1 million passengers in months," January 1, 2022, http://www.xinhuanet.com/english/asiapacific/20220113/03381e9d25614efbbf356c6e04e9daa1/c.html.

37. Martinus, "ASEAN Smart Cities Networks: A Catalyst for Partnerships," April 21, 2020, https://www.iseas.edu.sg/wp-content/uploads/2020/02/ISEAS_Perspective_2020_32.pdf.

38. Jamal M. Gawi, "The touch challenges of building smart cities in ASEAN: Jakarta Post contributor," The StraitsTimes, March 28, 2019, https://www.straitstimes.com/asia/se-asia/the-tough-challenge-of-building-smart-cities-in-asean-jakarta-post-contributor.

39. Yokota Masafumi, "Japan's support for smart city development in ASEAN- Progress of smart JAMP and guidebook," Ministry of Land, Infrastructure, Transport and Tourism, October 18, 2021, http://ascnjapan2021.jp/eng/dl/document/yokota.pdf.

40. Ibid.

41. Ibid.

42. Gawi, "The touch challenges of building smart cities in ASEAN: Jakarta Post contributor," https://www.straitstimes.com/asia/se-asia/the-tough-challenge-of-building-smart-cities-in-asean-jakarta-post-contributor.

43. Asia IoT Business Platform, "Smart City in Myanmar: Opportunities and Challenges," September 23, 2019, https://iotbusiness-platform.com/insights/smart-city-in-myanmar-opportunities-and-challenges/.

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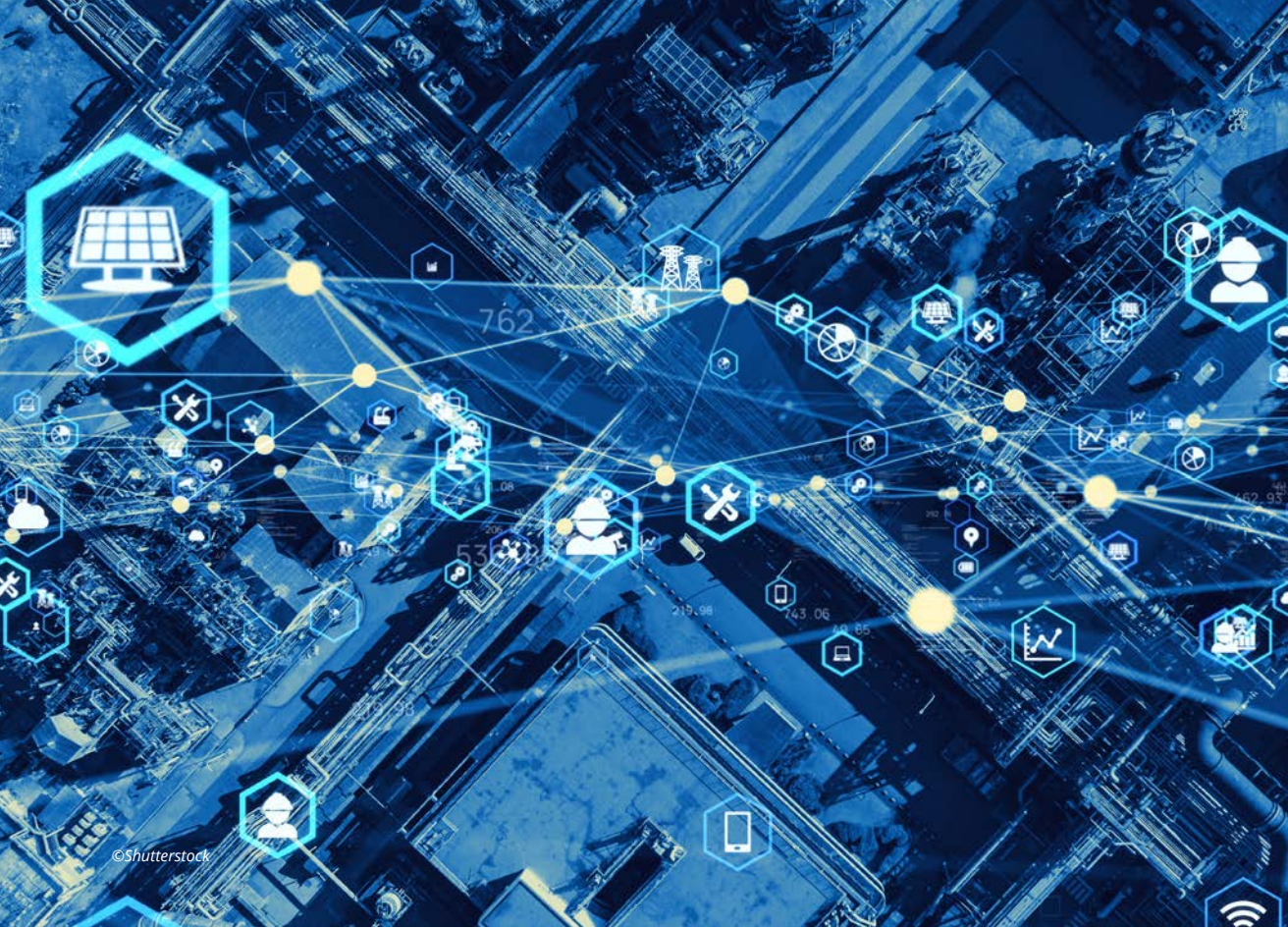
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BLOCKCHAIN TECHNOLOGY:
A Key Enabler of Future Smart Supply Chain Management

SOPHEAP ING   **VATANA CHEA**

Introduction

Increasing attention has been drawn to the concept of smart cities in many countries as they undergo rapid urbanization, and Cambodia is no exception. The Cambodian government has been promoting urbanization while ensuring that the cities are not only operated with smart technologies but also with sustainability and inclusiveness. The current administration has even chosen Phnom Penh, Battambang, and Siem Reap to partake in the ASEAN Smart Cities Network (ASCN). This regional platform encourages collaborative efforts among ASEAN countries in accelerating the development of sustainable urbanization.[1] This initiative has shown how committed the government is to achieving its goals even though progress has been hindered by various practical challenges, including implementing blockchain technology in the supply chain management system.

Supply chain management is a multi-echelon and complex process that entails different stakeholders. Yet, it depends on a centralized management system that requires all supply chain parties to place their trust in one organization to keep records of all the valuable and sensitive information. But such an information management system also contains the risk of a single point of failure whereby a fiasco in a part of the system can cause the rest of the system to be dysfunctional, thereby increasing the entire system's susceptibility to cyber-attacks, errors, or corruption. Any disruptions along the supply chain could result in a substantial loss of revenue or raise the cost of products for end consumers since the companies can

now produce less than before or cannot supply enough goods or services to the market. In a possible scenario, it can even harm the well-being of consumers if the products, especially food or pharmaceutical goods, are somehow contaminated due to supply chain failure.

On the other hand, there has also been an increasing demand from businesses and consumers for data about products' quality, originality, authenticity, and sustainability.[2] Hence, blockchain technology is proposed as a solution that would transform the supply chain management to be smarter since it can act as a distributed database, allowing for better efficiency, transparency, and traceability to resolve the problems above.[3]

Using desk review and systematic reasoning, this paper critically investigates the potential applications of blockchain technology in transforming conventional supply chain management mechanisms, which constitutes one of the core areas of smart cities formation as these cities' operations are anchored in interactions and cooperation among local stakeholders, companies, and end consumers.[4] Additionally, we discuss challenges in implementing blockchain-based supply chain management in the context of Cambodia, followed by policy recommendations to capitalize on the opportunities that such technology has to offer.

1. United Nations in Cambodia, "Workshop on Sharing Experience and Dissemination of a Smart City Concept for Sihanoukville," 2021, https://cambodia.un.org/en/163945-workshop-sharing-experience-and-dissemination-smart-city-concept-sihanoukville.

2. Denisolt Shakhbulatov et al., "How Blockchain Enhances Supply Chain Management: A Survey," IEEE Open Journal of the Computer Society 1 (September 21, 2020): 230–49, doi:10.1109/OJCS.2020.3025313.

3. Sara Saberi et al., "Blockchain Technology and Its Relationships to Sustainable Supply Chain Management,", no. 7 (April 3, 2018): 2117–35.

4. Diana Rocío Sánchez Martínez et al., "Smart Cities' Challenge: How to Improve Coordination in the Supply Chain," Innovation, Technology and Knowledge Management, 2017, 129–42, doi:10.1007/978-3-319-40895-8_10.

What Is Blockchain Technology?

Blockchain technology is a digital distributed ledger that permanently stores information about transactions on the network and is accessible to all relevant stakeholders. The difference between a blockchain and a typical database is how the data is stored and structured. While a database structures data into a table with many rows and columns, blockchain gathers, groups up, and stores all data in a block with a certain storage capacity. Once a block is filled with information, it is then chained with other blocks that were also saturated previously, forming a large chain of blocks or a blockchain. In addition, any new blocks filled with data will be chained with the existing blocks. Blockchain is also differentiated into two types: private/permissioned blockchain and public blockchain, designed based on network participants and the rules governing the blockchain itself. In the private blockchain, all parties are aware of each other's identity, and permission or invitation is required to partake in the network. In addition, access control is usually in the hands of multiple members or an organization. Alternatively, in the public blockchains, all the transaction data is available and transparent to the public while participants' anonymity is maintained.[5] In the case of Bitcoin, all information, including the owner's real identity stored in the block, is also encrypted and can only be decrypted by the owner.

Another most important concept of blockchain is its high security. It should be noted that besides data/information, each block in the chain has a unique hash (a 256-bit number that will be changed if information in the block is mined) and a hash of the previous block. Any attempt to tamper with any block must re-mine that block and all the blocks that come after it. Moreover, mining a block is not an easy task. It is extremely difficult for a large chain, as miners must find an accepted hash called the Golden Hash out of approximately 4 billion combinations for a block. But even though a miner manages to find a way to work on the hash duties, the blockchain has another trick to secure the data by distributing a full copy of the blockchain to all nodes at various locations connected to the chain. Nodes are computers or users involved in the network who will evaluate and verify when a new block is sent to them to ensure that it has not been tampered with.[6]

Simply put, when a new block enters a chain, nodes will evaluate its consistency with the history and rules. Once the majority of the nodes (more than 50 percent) reach a consensus and acknowledge the block's validity, the new block will be added to the chain.[7] Otherwise, it will be rejected. In blockchain-based supply chain management, the verification process is performed by a smart contract. This computer protocol embeds pre-determined approved rules and/or penalties in the computer system and enables the automatic execution of contracts.[8] Figure 1 below illustrates how blockchain technology in supply chain management transactions works.

5. Yingli Wang, Jeong Hugh Han, and Paul Beynon-Davies, "Understanding Blockchain Technology for Future Supply Chains: A Systematic Literature Review and Research Agenda," Supply Chain Management 24, no. 1 (March 4, 2019): 62–84.
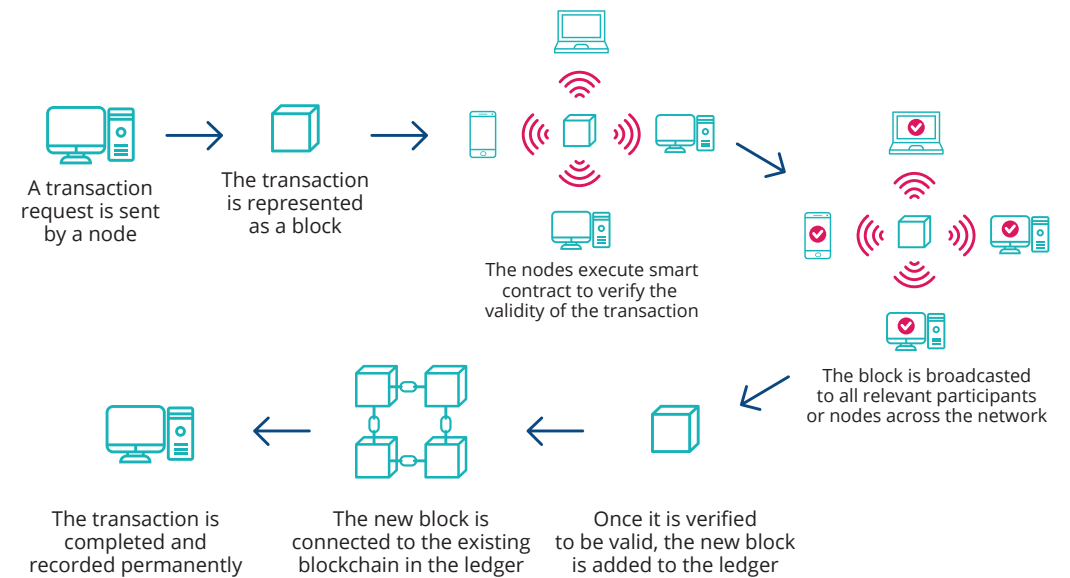
6. Yingli Wang et al., "Making Sense of Blockchain Technology: How Will It Transform Supply Chains?," International Journal of Production Economics 211 (May 1, 2019): 221–36.

7. Ibid.

8. Hokey Min, "Blockchain Technology for Enhancing Supply Chain Resilience," Business Horizons 62, no. 1 (January 1, 2019): 35–45.

Figure 1: Blockchain Technology Transaction Process

A transaction request is sent by a node

The transaction is represented as a block

The nodes execute smart contract to verify the validity of the transaction

The block is broadcasted to all relevant participants or nodes across the network

Once it is verified to be valid, the new block is added to the ledger

The new block is connected to the existing blockchain in the ledger

The transaction is completed and recorded permanently

Source: Authors

In this sense, blockchain only allows for data storing and distributing, not editing, which is almost impossible. It is in this immutable nature of public blockchain that no single party or node alone can alter the data or block, making the system more resilient to errors, deletion, frauds, or hacking. For many developing countries, including Cambodia, which experience frequent blackouts and unstable internet connections, blockchain technology also plays a better role than databases run by multiple servers jointly. Additionally, trusted third party or middleman involvement is no longer necessary in this sort of decentralized system. Indeed, blockchain technology encompasses several characteristics such as disintermediation, security, transparency, and automation that are crucial in facilitating credible information dissemination, coordination, and greater efficiency throughout the complicated and multi-stakeholders supply chain management system.

Blockchain in Smart City Supply Chain Management

The smart city concept concerns the operation system of a city that utilizes information and communication technologies (ICTs) to address public issues, improve living standards and citizens' welfare, and promote sustainable development. Smart city databases and smart control systems allow a wide array of data to be collected and analyzed to achieve efficient resource management and allocation. The smart supply chain is a major part of the smart city ecosystem that significantly impacts the quality of life. Before diving into blockchain application,[9] it is useful to understand that the supply chain here refers to a system comprising activities and the flow of related information generated as products and services make their way from the supplier

9. Junfeng Xie et al., "A Survey of Blockchain Technology Applied to Smart Cities: Research Issues and Challenges," IEEE Communications Surveys and Tutorials 21, no. 3 (July 1, 2019): 2794–2830, doi:10.1109/COMST.2019.2899617.

side to the end consumer side; and the act of managing relevant actions and information in the supply chain process, including sourcing, procurement, conversion, and all logistics, is known as supply chain management. Noting that the supply chain management activities often generate sensitive and/or confidential information about an organization or multiple actors involved in the process, the type of blockchain technology deployed in such a system should be the private one that allows limited network participants.

The employment of blockchain can address a number of existing challenges in traditional supply chain management systems. It should be highlighted that the technology can provide complete information about products digitally since it can accommodate various types of data such as quality, quantity, date, or state of a product, etc. Other available details that could also be displayed and directly acquired by relevant stakeholders in the blockchain system include product-specific data (product features and performance), ownership (list of the product owners in chronological order), location (past and current locations of a product), impacts on the environment (emission of carbon dioxide, energy consumption, etc.).[10] However, not all related

parties can access all products and/or their information. Security arrangements can be carried out to ensure that only certain groups of people can gain access to particular products that match their digital keys.

Besides, blockchain guarantees fair trade, and no scamming or swindling will occur.[11] Blockchain technology encompasses a smart contract feature that coordinates the transfer of ownership of products among stakeholders or business counterparts. In particular, a smart contract is a digitally self-executing contract agreed upon by buyers and sellers, and it will run when predetermined conditions are met. Simply put, when stakeholders exchange products with each other or add new information to the product's profile, they must fulfill the contractual obligations set out in the smart contract first before any real changes can happen or the trade deal can be successfully finalized. Only when the smart contract verifies the authenticity of the agreement or the information will it authorize the actions accordingly, and details of new data would be automatically updated in the blockchain database. The smart contract reduces the need for a trusted intermediary or arbitrator to facilitate trades.

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10. Wang, Han, and Beynon-Davies, "Understanding Blockchain Technology for Future Supply Chains: A Systematic Literature Review and Research Agenda."

11. Saberi et al., "Blockchain Technology and Its Relationships to Sustainable Supply Chain Management."

Figure 2: *Blockchain in Supply Chain Management*

| Supplier | Manufacturer | Distributor | Retailer | Consumer |
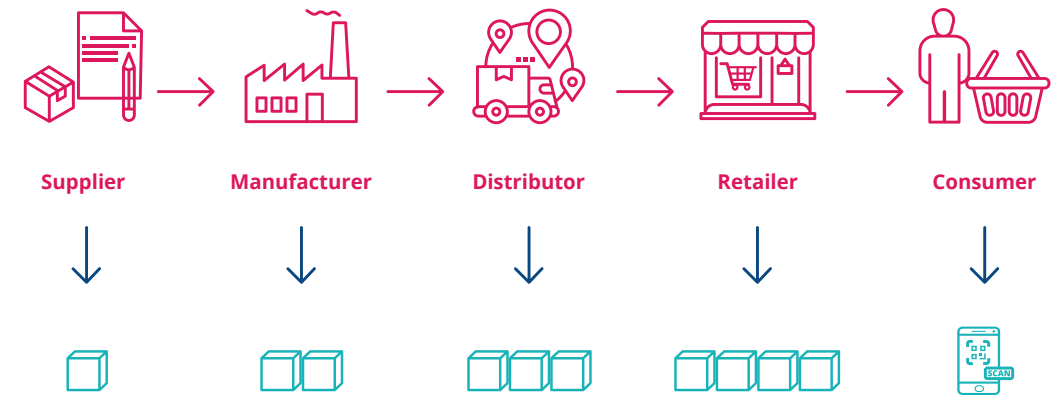
Source: *Authors*

Presenting in figure 2 is an illustration of blockchain technology in supply chain management and how the smart contract works. Blockchain technology's immutable information about ownership recorded over time allows real-time tracking and traceability so that companies can trace the sources of contaminated products or detect counterfeit products efficiently and quickly. Companies can then take necessary actions to prevent the products from harming consumers. Additionally, data obtained from tracking products in all stages can be beneficial for identifying potential and minimizing risks and assessing suppliers' efficacy and performance to manage or reduce production costs. Furthermore, visibility of products' information would facilitate quality assurance and quality control, especially for consumers and regulatory bodies to make sure that the goods are produced in compliance with the regulations and standards. Lastly, sustainable supply chain management needs to consider environmental impacts, so it is crucial to acquire transparent data about manufacturers' carbon footprints, environmentally friendly inputs, or production processes, which can also be made possible by blockchain technology.[12] The following table provides several examples of how major multinational corporations worldwide use blockchain technology in their supply chain management or business transactions.

Table 1: *Recent Blockchain-powered Initiatives Implemented by International Companies*

Company	Blockchain-based Initiatives
Tomcar	Tomcar is an Australian vehicle manufacturer that allows three clients in Israel and Taiwan, Province of China, to opt for Bitcoin as a payment method, and the company also uses the cryptocurrency to make payments to some suppliers. As a result, the company can reduce its expenses as they do not incur international payment fees.

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12. Denisolt Shakhbulatov et al., "How Blockchain Enhances Supply Chain Management: A Survey," IEEE Open Journal of the Computer Society 1 (September 21, 2020): 230–49, doi:10.1109/OJCS.2020.3025313.

Company	Blockchain-based Initiatives
Walmart	As the world's largest retail company, Walmart partners with IBM to use blockchain technology to enhance the traceability of food products to ensure food safety. Stakeholders in the food supply chain are connected by the Food Trust network and have access to records of food system data.
BHP	BHP, a leading mining company in Australia, uses blockchain technology for supplier verification and ensures its compliance with social, environmental, and governance criteria throughout the supply chain. The company utilized MineHub, a blockchain-enabled platform, to complete a 14 million USD iron ore trade with China Baowu Steel.
Sappi and Birla Cellulose	A pulp and paper company Sappi in South Africa collaborates with fabric producer Birla Cellulose in India to build a blockchain-based platform known as GreenTrack to enable traceability of fabric products from sustainable forest to retail.
Walmart Canada	Walmart Canada leveraged a blockchain-powered invoice and payment system called DL Freight to execute transactions automatically and generate data for more than 500,000 annual shipments. Tracking along the supply chain was facilitated by GPS and IoT-enabled devices. This solution has cut down around 97 percent of invoice disputes.
De Beers	De Beers is an international diamond mining company that incorporates blockchain technology into the management of diamond mining, production, and distribution. The technology provides visibility into the provenance of the diamonds so that the company can guarantee the quality of diamonds sold to customers.

Source: getsmarter[13]

Barriers to Implementation

Despite the positive impacts that blockchain technology can bring to the table, some challenges are likely to arise amid the introduction of the technology to the supply chain system. First, blockchain technology was only invented in 2009 by Satoshi Nakamoto, who also founded Bitcoin even though the idea of distributed ledgers was initiated in 1991. As a result, current initiatives that adopt blockchain-based supply chain systems are still in the early stage, and many uncertainties remain. Therefore, further investigations into long-term effects on governance, economy, and sustainability are still needed. Second, the willingness, commitment, and financial support from the government and private sector may be a big challenge, as the initial investment or upfront cost of building a blockchain infrastructure and developing the technology itself is huge. Not to mention the licensing costs if we go for a paid blockchain technology solution. Hence, hesitation and resistance might occur, and it might not be easy to convince businesses and organizations to opt for such technology adoption.

Third, the expertise required to maintain and develop blockchain can be another issue for countries such as Cambodia that lack human resources. Thus, building a team of IT professionals who clearly understand the supply chain processes in the context of Smart Cities and have profound knowledge of blockchain development and maintenance can be difficult, if not impossible. Fourth, the private blockchain, the most common type of blockchain used in supply chain management, is less secure because the network contains much fewer nodes, unlike the public blockchain. Therefore, it is also much easier for a single node to tamper with the data. Not to mention that nodes in private blockchain are likely to know each other, leading to a higher probability of collusion to change a block. Fifth, blockchain technology allows users to ensure that no information is altered or no block is tampered with but does not prevent incorrect information from being added to the chain in the first place. Blockchain cannot prevent human error, nor can it evaluate the quality of information. Finally, the consensus concept of blockchain technology limits its scalability and obstructs large-scale implementation because it will be increasingly more difficult to gather enough agreement to reach a consensus.

Conclusion and Recommendations

As Cambodia inches toward establishing smart cities, integrating blockchain technology into supply chain management is an opportunity it should capitalize on. Applying blockchain in the supply chain would improve operational efficiency, transparency, information management, and responsiveness, further enhancing product safety, supervision, and management systems. It should be highlighted that the benefits of blockchain go beyond the concept of supply chain management in the context of Smart Cities but into FinTech and a paperless organization concept. Nevertheless, deploying a blockchain-driven supply chain might face obstacles such as insufficient support and commitment from the leadership level in organizations, shortage of human resources, and scalability issues. To minimize problems and exploit the potential of blockchain, it is recommended that:

- The government should raise awareness about the significance of blockchain technology adoption to change people's perspectives and encourage them to embrace new technology that can address problems in the traditional

13. Getsmarter, "How Blockchain Will Radically Improve the Supply Chain," 2022, https://www.getsmarter.com/blog/market-trends/ how-blockchain-will-radically-improve-the-supply-chain/#:~:text=by%20blockchain%20technology.-,Efficiency,greater%20data%20 collaboration%20between%20stakeholders

supply chain. The upfront cost of blockchain technology should be seen as an investment, not a consumption.

- The government and private organizations should offer training for employees to equip them with the knowledge and skills essential for operating the system effectively. IT professionals should be sent abroad, especially to countries such as the US, the UK, Singapore and China, currently the global leaders in blockchain technology investment, to expand their knowledge and specialization.

- The government and private firms should invest in research and development to explore the possibility of incorporating blockchain-based supply chain practices in the local context and solutions to mitigate application shortcomings.

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**INFRASTRUCTURE
AND GREEN BUILDINGS**

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GREEN INFRASTRUCTURE TO ALLEVIATE PHNOM PENH'S FLASH FLOODING

PICHPISEY SOVANN   SOPHEA ROM PHY

Background

Rapid urban development opens the door for many advantages to citizens. Sustainability is an important consideration in urbanization. However, many developing countries, especially in Southeast Asia, have incurred urban flash floods at a frequent rate and are expected to be exposed to more of them as a result of climate change.[1] In a city, stormwater flows to sewers and low surfaces before flowing to the natural wetlands or other water bodies. In 2007, a devastating flood struck the Hue City of Vietnam affecting nearly 600,000 houses and causing economic damages of USD 275 million.[2] In October 2021, Cambodia's Phnom Penh and six other provinces faced critical flash floods[3], inflicting damages on approximately 900 families in Phnom Penh alone.[4] Urban flash flooding in Phnom Penh is a critical issue since the city is the core of commerce and residence. It is important to strategize sustainable urban planning to decrease flooding risks.

This alarming issue of urban floods requires sustainable flooding risk mitigation plans. Urban green space is deemed as a potential alternative to reduce flash flood risks in urban areas.[5] In urban planning, green space often refers to a particular area dedicated to a greenery landscape, that is, green space, occupied with various tree types and also water bodies like lakes, ponds and wetlands.[6] With this said, green spaces must often be proactively planned and promoted in metropolitan areas, which are of course known to be overflowing with gray infrastructure. Green space serves a host of benefits, from enhancing the environment to social well-being - social cohesion, equity, physical and mental health - to urban aesthetics.[7] A study examines the three scenarios to reduce flood risks in Rosario, Santa Fe, Argentina; the results suggest that the investment in flooding risks mitigation plan in which green infrastructure is prioritized significantly decreases the risks of flooding.[8]

Despite serving a multitude of purposes, green space is unfortunately overlooked in land-use master plans.[9] Green infrastructure in Phnom Penh, evidentially, has decreased to only 1.1m² green space per person compared to New York at 29.2m².[10] This article examines the urban flood risks in Phnom Penh and investigates how developing countries invest in green infrastructure to mitigate urban flood risks. Finally, the article proposes policy recommendations to fill the gaps and move

1. S. Heng et al., "Analysis of Public Perceptions on Urban Flood in Phnom Penh, Cambodia," in Water Security in Asia: Opportunities and Challenges in the Context of Climate Change, ed. Mukand Babel et al., Springer Water (Cham: Springer International Publishing, 2021), 690, https://doi.org/10.1007/978-3-319-54612-4_51.

2. Dengrui Mu et al., "Impact of Temporal Rainfall Patterns on Flash Floods in Hue City, Vietnam," Journal of Flood Risk Management 14, no. 1 (2021): 4, https://doi.org/10.1111/jfr3.12668.

3. "Phnom Penh and Six Other Provinces Face Flash Floods from Today," Khmer Times, September 6, 2021, sec. National, https://www.khmertimeskh.com/50929808/phnom-penh-and-six-other-provinces-face-flash-floods-from-today/.

4. Sopheak Khoun, "លោក យួង ស្រុង ៖ ទឹកជំនន់ស្ទើរគ្រោតខ្លោត បានស្រករស់ពីតំបន់តែអន្ធាគាគនៅតែតាមមើលលថៃ ពលរដ្ឋជានិច្ច," Kampuchea Thmey, October 30, 2021, sec. National, https://www.kampucheathmey.com/local-news/223340.

5. Hyomin Kim, Dong-Kun Lee, and Sunyong Sung, "Effect of Urban Green Spaces and Flooded Area Type on Flooding Probability," Sustainability 8, no. 2 (February 2016): 134, https://doi.org/10.3390/su8020134.

6. M. Benedict and E. McMahon, "Green Infrastructure: Smart Conservation for the 21st Century.," Renewable Resources Journal 20, no. 3 (2002): 13.

7. Lucy Taylor and Dieter F. Hochuli, "Defining Greenspace: Multiple Uses across Multiple Disciplines," Landscape and Urban Planning 158 (2017): 30, https://doi.org/10.1016/j.landurbplan.2016.09.024.

8. Erik Zimmermann et al., "Urban Flood Risk Reduction by Increasing Green Areas for Adaptation to Climate Change," Procedia Engineering, World Multidisciplinary Civil Engineering-Architecture-Urban Planning Symposium 2016, WMCAUS 2016, 161 (January 1, 2016): 2246, https://doi.org/10.1016/j.proeng.2016.08.822.

9. Alessandro Rigolon et al., "Access to Urban Green Space in Cities of the Global South: A Systematic Literature Review," Urban Science 2, no. 3 (September 2018): 13, https://doi.org/10.3390/urbansci2030067.

10. National Council for Sustainable Development, Phnom Penh Green City Strategic Plan 2017 - 2026, 2016, 45, http://ncsd.moe.gov.kh/sites/default/files/2019-05/Phnom%20Penh%20Green%20Strategic%20Plan.pdf.

Phnom Penh faster toward a fully sustainable smart city.

Green Area, Green Space, Green Infrastructure

Lexically, terms constituting the areas dedicated to greenery have varying definitions and interpretations. There are a number of terms used interchangeably. As is observed, three outstanding terms "green areas", and "green space", "green infrastructure" are worth to be further examined.

Green Areas can be lexically broken down into "green" and "area" to describe areas that are filled with natural and green elements. Green areas are described as areas contributed to the ecological, aesthetic, and/or public needs of a population cluster such as cities.[11] Green areas are most frequently used by researchers from multidisciplinary journals such as Landscape and Urban Planning and Policy and Health.[12] Green areas and green spaces are used interchangeably in the Phnom Penh Green Strategic Plan, finalized in 2016. Both terms are used to describe open areas dedicated to capture rainwater, reduce flooding risks, and improve biodiversity.[13]

Green Space or greenspace has been lexicalized as two words green and space, in which green as an adjective describes space. Warren defined green space as "land

covered with some form of vegetation."[14] Different disciplines adopt and assign various meanings to green space due to their distinguished objectives and methodologies.[15] Green space is interpreted in a systematic review as water bodies or vegetation areas in a landscape such as trees on streets, parks, gardens, and food crops.[16] Similarly, the World Health Organization refers to a particular area dedicated to a greenery landscape occupied with various tree types and sometimes water bodies like lakes, ponds and wetlands.[17] Urban green space is an ingredient of "green infrastructure".[18]

Green Infrastructure is a city-wide or landscape-wide[19] interconnected network of natural and semi-natural open spaces comprising green spaces, water bodies, and other green elements,[20] all of which are aimed at effectuating stormwater management, environmental, and social wellbeing[21] while adding amenity and aesthetic value to tandem.[22] Green

infrastructure has received growing popularity in terms of instilling climate change resilience and sustainable development in city dwellers.[23] The Green Infrastructure Guide by the Ministry of Public Works and Transport of Cambodia and National Council for Sustainable Development of the Ministry of Environment of Cambodia published in August 2019 distinguishes green infrastructure at three levels, town scale, local scale, and all scales.[24] It defines green infrastructure as the use of vegetation and natural areas including water runoff systems to create resilience in water, temperature, and air quality management.[25] Therefore, in this paper, we use green infrastructure as a convergence of manmade vegetation and areas such as parks, gardens, slopes, and sewage systems and natural areas such as forest areas and biodiversity.

Urban Flood Risks and Its Impacts

One of the key drivers of increasing flood risks in urban areas is land cover change. To illustrate, permeable surfaces like vegetation and water bodies are being diminished for urbanization. Permeable lands that are vegetation and some water bodies have been cleared and infilled to make way for new residential areas, as seen in Figure 1. This trend exerts partial influence on increasing flood extent, inferring the correlation between each land cover type and flood extent (Figure 2).

Figure 1. *Spatio-Temporal Extent of (a) Phnom Penh's Land Cover Change and (b) Flood Overlaying on Land Cover Types*

14. John Lawrence Warren, "Green Space for Air Pollution Control," *Monticello, Il., Council of Planning Librarians* 490 (1973): 118.

15. Mark J. McDonnell, "The History of *Urban Ecology*: An Ecologist's Perspective," in Urban Ecology (Oxford: Oxford University Press, 2011), 11, https://doi.org/10.1093/acprof:oso/9780199563562.003.0002.

16. Taylor and Hochuli, "Defining Greenspace: Multiple Uses across Multiple Disciplines," 29.

17. World Health Organization. Regional Office for Europe, Urban Green Spaces: A Brief for Action (World Health Organization. Regional Office for Europe, 2017), 2, https://apps.who.int/iris/handle/10665/344116.

18. Ibid.

19. Konstantinos Tzoulas et al., "Promoting Ecosystem and Human Health in Urban Areas Using Green Infrastructure: A Literature Review," *Landscape and Urban Planning* 81, no. 3 (June 20, 2007): 169, https://doi.org/10.1016/j.landurbplan.2007.02.001.

20. "Key Definition: Green Infrastructure," *World Green Infrastructure Network* (blog), April 12, 2021, https://worldgreeninfrastructurenetwork.org/key-definition-green-infrastructure/.

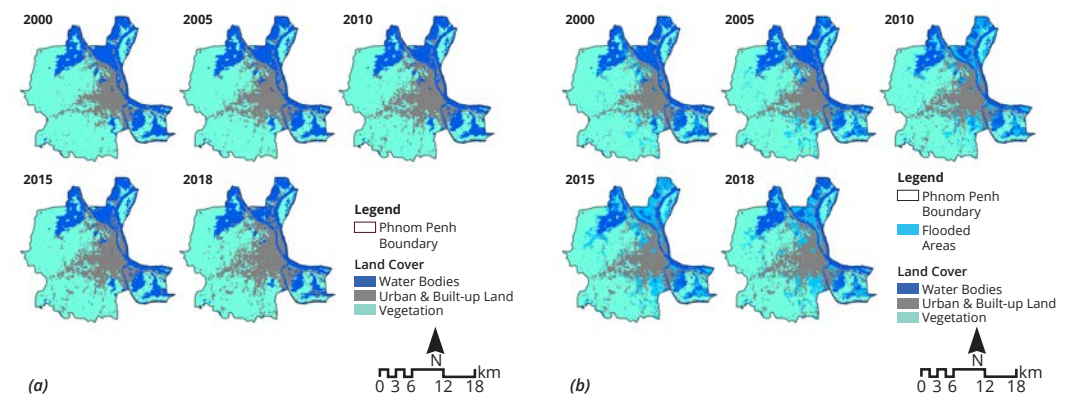**21.** Benedict and McMahon, "Green Infrastructure."

22. "Enhancing Sustainable Communities With Green Infrastructure," Reports and Assessments (United States Environmental Protection Agency, October 2014), 18, https://

11. Mediha Burcu Silaydin Aydin and Duygu Çukur, "Maintaining the Carbon–Oxygen Balance in Residential Areas: A Method Proposal for Land Use Planning," Urban Forestry & Urban Greening 11, no. 1 (January 1, 2012): 90, https://doi.org/10.1016/j.ufug.2011.09.008.

12. Taylor and Hochuli, "Defining Greenspace: Multiple Uses across Multiple Disciplines," 27.

13. National Council for Sustainable Development, Phnom Penh Green City Strategic Plan 2017 - 2026, 53.

www.epa.gov/smartgrowth/enhancing-sustainable-communities-green-infrastructure.

23. Sara Meerow and Joshua P. Newell, "Spatial Planning for Multifunctional Green Infrastructure: Growing Resilience in Detroit," *Landscape and Urban Planning* 159 (March 1, 2017): 70, https://doi.org/10.1016/j.landurbplan.2016.10.005.

24. International Centre for Environmental Management, "Green Infrastructure Guide" (Ministry of Public Works and Transport, August 2019), 1, https://ncsd.moe.gov.kh/sites/default/files/2019-10/Green%20Infrastructure%20Guide_August%202019_En.pdf.

25. Ibid.

Figure 2. Rate of Phnom Penh's Flood and Land Cover Change (water bodies excluding the Mekong River, urban & built-up land, and vegetation)
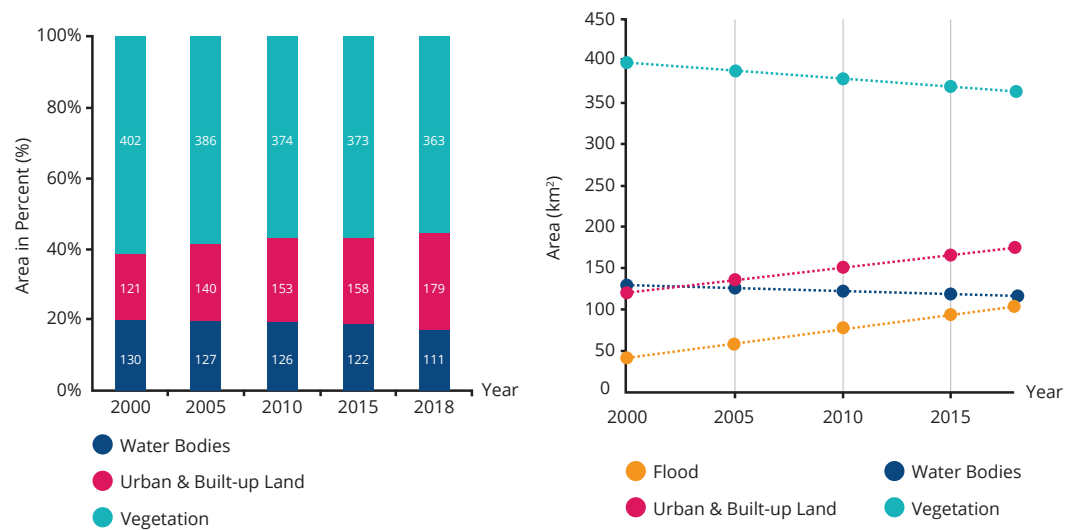
Increased urban flooding, and associated flood risks, are also attributed to climate change. Climate change induces irregular patterns of rainfall with increasing intensity.[26] Flood risks become more pronounced, provided that the population density continues to rise. Simultaneously, some residents live in the flash-flood-prone regions, already realizing damages to their livelihood. Since urban floods stem from drainage systems unable to curb excessive rainfall, increasing rainfall implies increasing flood risks. Flooding causes severe disruption to daily activities and social infrastructure, impacting citizens both during and after the flood event. In the case of prolonged floods, economic activities will be disrupted in full force.

Green Infrastructure to Mitigate Urban Flood Risks

To this day, developed countries have initiated concepts and models, akin to the green space model, to mitigate urban flood risks. Concepts like Low Impact Development (U.S.), Water Sensitive Urban Design (Australia), Sustainable Urban Drainage Systems (UK), Active-Beautiful-Clean (Singapore), and also Sponge City (China) are all dedicated to managing urban storm or flood waters by the use of urban green space. The models encompass practices such as green space containing water bodies, permeable and green parking lots, green roofs, and permeable pavement. The purpose of green infrastructure essentially mimics the natural flow and systematic water cycle, combating the reduction in water infiltration and evaporation typically caused by a prevalence of gray infrastructure.[27]

The Sponge City concept is characterised by an advanced urban water management system that aims to absorb and re-use rainwater efficiently. It is a state-of-the-art construction model of rainwater and water runoff management, used extensively in developed countries.[28] China's Sponge City by design solves problems associated with rainwater, flooding, water purification, groundwater recharge, and many more.[29] It takes advantage of rainwater through rainwater absorption, storage, and recycling.[30] The sponge city concept marries urban development and rainwater management. However, its construction requires many multi-sectoral corporations and intersectional collaboration across many aspects ranging from urban planning, architectural design, engineering, construction implementation, and construction management.[31] The Sponge City concept is by far the most advanced construction model of green infrastructure that systematically and comprehensively tackles environmental problems related to water and water runoff. Hence, green infrastructure is of paramount importance, notably improving the welfare of urban inhabitants. Both physically, in terms of infrastructure needs, and mentally, as they are in general happier.

Recommendations

A myriad of countries have stressed the importance of green infrastructure. Some of them are classified as developing nations, which currently reach a remarkable threshold of emphasizing green infrastructure in their urban planning. Alongside pressing global and local issues such as changes in land use and drastic climate change, flooding is a global concern. To address this concern, the above analysis has provided us with grounds to recommend three key actionable policies.

First, flooding in urban areas or urban flooding is dreadful and prevalent in tandem with rising demographics and unpredictably high rainfall intensity which leads to incapacitated drainage systems. Simultaneously, such type of flooding is significantly attributed to little to no portion of permeable or porous space in urban areas. It is of general consensus that flooding will be more intense and of long duration as a result of climate change and other changes on land. Taking that into consideration, future master plans must proactively assess and address all of these challenges, and here, urban green spaces should be emphasised more than ever as a potential solution to them.[32]

Second, the Green Infrastructure Guide, by the Ministry of Public Works and Transport of Cambodia and the National Council for Sustainable Development of the Ministry of Environment of Cambodia, should be taken into serious consideration in urban planning. With the rise in building construction happening in cities in Cambodia, there should be a strong institutional mechanism

26. "Climate Change Indicators: Heavy Precipitation | US EPA," accessed May 6, 2022, https://www.epa.gov/climate-indicators/climate-change-indicators-heavy-precipitation.

27. Chitresh Saraswat, Pankaj Kumar, and Binaya Kumar Mishra, "Assessment of Stormwater Runoff Management Practices and Governance under Climate Change and Urbanization: An Analysis of Bangkok, Hanoi and Tokyo," *Environmental Science & Policy* 64 (October 1, 2016): 102, https://doi.org/10.1016/j.envsci.2016.06.018.

28. Yongjun Sun et al., "Integration of Green and Gray Infrastructures for Sponge City: Water and Energy Nexus," *Water-Energy Nexus* 3 (January 1, 2020): 30, https://doi.org/10.1016/j.wen.2020.03.003.

29. Sun et al., "Integration of Green and Gray Infrastructures for Sponge City," 30.

30. Wang, Jiang, and Zhang, "Sponge City Policy and Sustainable City Development."

31. Huan Liu, Yangwen Jia, and Cunwen Niu, "'Sponge City' Concept Helps Solve China's Urban Water Problems," *Environmental Earth Sciences* 76, no. 14 (July 11, 2017): 473, https://doi.org/10.1007/s12665-017-6652-3.

32. Erik Zimmermann et al., "Urban Flood Risk Reduction by Increasing Green Areas for Adaptation to Climate Change," Procedia Engineering, World Multidisciplinary Civil Engineering-Architecture-Urban Planning Symposium 2016, WMCAUS 2016, 161 (January 1, 2016): 2245, https://doi.org/10.1016/j.proeng.2016.08.822.

to coordinate and lead the construction and management of green infrastructure. The mechanism, hence, should encourage public participation and private corporations to be involved in planning and implementing green infrastructure.

Third, the construction of green infrastructure is a collaborative work across different fields involved.[33] It is important to formulate a more mature and corresponding green infrastructure policy for actors from various sectors to collaborate in a more systematic way. Technical support such as engineering technologies, industrial support, and digital technologies should be provided to construct, manage, and maintain not just the physical aspects of the green infrastructure, but also the digital aspects to provide data support for green infrastructure policy according to local conditions.

Conclusion

Green infrastructure is of particular relevance to Phnom Penh, where the risks of flooding rise in tandem with the city's growing population, and its rapid urban development. It is clear that the citizens of Phnom Penh currently lack access to nature, and green spaces, and the promising concept of green infrastructure could address this. There are also many compound effects like urban heat islands in most of the western Phnom Penh,[34] and deprived social well-being due to pollution[35] that validates the start of green infrastructure in Phnom Penh. With all benefits mentioned, especially the arising concerns over current and future floods in Phnom Penh, green infrastructure is a viable solution to alleviating Phnom Penh's flash flooding.

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33. Huan Liu, Yangwen Jia, and Cunwen Niu, "'Sponge City' Concept Helps Solve China's Urban Water Problems," *Environmental Earth Sciences* 76, no. 14 (July 11, 2017): 473, https://doi.org/10.1007/s12665-017-6652-3.

34. Gulam Mohiuddin and Jan-Peter Mund, "Application of Land Surface Temperature Analysis in Urban Green Spaces: Case Studies from South Asia," *GI_Forum 2021*, Volume 9, (December 28, 2021): 208, https://doi.org/10.1553/giscience2021_02_s202.

35. "Green City Strategic Planning Methodology" (National Council for Sustainable Development (NCSD), Royal Government of Cambodia (RGC), the Global Green Growth Institute (GGGI) and the International Centre for Environmental Management (ICEM), August 2016), 8.

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SMART TECHNOLOGY SUPPORTING TRADITIONAL AND BIOCLIMATIC BUILDING FUNCTIONS IN REDUCING COOLING ENERGY DEMAND IN CAMBODIA

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DIRK SCHWEDE

KIMNEH TAING

VIRAK HAN

Cambodia has been experiencing significant urbanisation, economic and population growth over the last decade with projections showing that this trend will continue until 2035 and beyond.[1] Moreover, buildings are responsible for one third of the total final energy consumption in Phnom Penh[2] and with increasing housing needs, no intervention will inevitably lead to an exponential increase both in energy consumption especially for cooling, and in related emissions. Furthermore, despite the low penetration rate of air-conditioning (AC) in the country, according to the International Energy Agency, AC sales have doubled between 2015-2018.[3]

Smart buildings can save energy by using advanced sensors and automated controls in heating, ventilation, and air conditioning (HVAC), lighting, plug loads, window shading technologies, as well as data analytics. In the same direction, sustainable building strategies can help users control their energy use and at the same time provide a highly efficient, healthy and comfortable living environment. A first step towards such strategies can be supported by existing technologies such as indoor environmental monitoring systems using data loggers as input devices to evaluate the existing conditions.

A related methodology has been developed as part of the sustainable building research conducted within the Build4People project. Indoor environmental conditions are being monitored for in-use residential buildings

in Phnom Penh using Wi-Fi connected sensors recording and transmitting indoor temperature, humidity and CO_2 concentration data. This method enables us to have real time data of the actual conditions and along with app-based questionnaires, we can have a deep understanding of the building's operation as a starting point to design strategies for helping users deal with the pressing climate conditions of the location.

Based on this work an overview of climate related smart-building solutions and the possible benefits of building control and room automation are presented and discussed.

The total population of Phnom Penh has increased significantly over the last 30 years. According to the National Cambodian Census data and population estimations in the Cambodia Socio-Economic Survey, the population within its municipal boundaries has increased from 1.36 million to 2.28 million between 2010 and 2019.[4] The population increase is largely based on a period of strong growth between 2010 and 2019, during which the labour force increased by 53 percent, and which continued but declined between 2014 and 2019.[5]

Since the '00s, this growth has been characterised by significant investment activities in the construction sector and a steep increase in land prices all over the city, that led to a change in building design, and a consequent rise in the electricity

1. United Nations, Department of Economic and Social Affairs, Population Division, "Word Population Prospects - Key Findings WPP 2015, Key Findings and Advance Tables. Working Paper No. ESA/P/WP.241", 2015.

2. Asian Development Bank, *Cambodia: Energy Sector Assessment, Strategy, and Road Map,* Asian Development Bank, 2018.

3. IEA, The Future of Cooling in Southeast Asia, https://webstore.iea.org/the-future-of-cooling-in-southeast-asia.

4. National Institute of Statistics (NIS), *Cambodia Socio-Economic Survey 2007, Housing Conditions,* Phnom Penh, 2008; National Institute of Statistics (NIS), Cambodia Socio-Economic Survey 2010, Phnom Penh, 2011; National Institute of Statistics (NIS), *Consumer Price index,* Phnom Penh, https://www.nis.gov.kh/nis/cpi/Jul2019.htm; Cambodian Cencus, "Final-Leaflet-Census-Report-2019-Eng", 2019.

5. National Institute of Statistics, Ministry of Planning, "Cambodia Labour Force Survey 2019", 2019.

Smart Technology Supporting Traditional and Bioclimatic Building Functions in
Reducing Cooling Energy Demand in Cambodia
Christina KARAGIANNI, Dirk SCHWEDE, Kimneh TAING and Virak HAN

DIGITAL INSIGHTS

consumption per capita from about 46.9 kWh in 2004 to 659.5 kWh in 2019.[6] In this context of rapid economic growth where incomes and consumption levels are rising, greenhouse emissions are rising along with them.

Cambodia's footprint has been increasing drastically since the beginning of the 1990s. Emission levels increased from 0.21 $tnCO_2$ per capita in 2005 to 0.92 $tnCO_2$ per capita in 2020.[7] The emissions growth has been particularly strong during the years of high Gross Domestic Product (GDP) growth rates. This increase is of course related to increasing energy consumption, with the building sector being the largest final energy consumer after transport and industry, with an estimated share of 40 percent.[8] In a report from the United Nations Development Program (UNDP) on energy efficiency, it is estimated that the energy consumption of Phnom Penh's buildings will more than double by 2040 due to new construction following the high economic growth and the increasing demand for cooling due to Southeast Asia's hot and humid climate.[9] The same report estimated household energy consumption, showing that the main energy use appliances in residential buildings are lamps, electric cookers, refrigerators and air conditioners. This is expected to change, as with increasing income levels the penetration level of electrical devices is also very likely to increase.

Regarding AC use in Cambodia, an interesting finding of the study is that people who do have air conditioners in their home use them on average 14 hours per day, mostly at night time when they come back from work and need maximum comfort when they sleep. While at the same time it is predicted that air conditioner and refrigerator sales will most likely skyrocket in the upcoming years. From studies in hot humid countries, it has been shown that households spend 35 percent to 42 percent more on electricity when they use AC[10] but that in addition, that having an AC unit strongly improves how satisfied Cambodians are with their thermal environment.[11] Increasing demand for thermal comfort and thus for cooling will inevitably contribute significantly both to a further increase of energy use and to greenhouse gas emissions, due to emissions of Hydrofluorocarbons (HFCs), CO_2, and black carbon from the mostly fossil fuel-based energy that power air conditioners and other cooling equipment. Besides the environmental impact, there are going to be social impacts too if climate change makes indoor cooling essential for the health and safety of the majority of the population, since 27 percent of the total households in Cambodia are currently energy insecure.[12]

Apart from the predicted increase of AC ownership and need for comfort, a surge in energy demand will be driven by the foreseeable population growth in Phnom Penh. The Phnom Penh Urban Transport Master Plan, developed by the Japan International Cooperation Agency (JICA), projects that Phnom Penh's population will reach 2.9 million inhabitants by 2035. The United Nations (UN) expects an increase to 2.6 million inhabitants by 2030. At the same time, the national urbanization level is expected to increase to 26 percent. According to the UN, Cambodia will be one of the most rapidly urbanising countries between 2018 and 2050 with an annual rate of urbanization of 1.8 percent.[13]

As these trends continue, regional policy makers should prepare to meet the future demands and challenges that come with this extraordinary rhythm of urbanisation. Implementation of smart building technologies in Cambodian cities could provide some long- and short-term solutions for improving the overall quality of life (QoL) of the urban population, as a study done by the McKinsey Global Institute (MGI) states that technology solutions could improve QoL within Southeast Asian cities by approx. 30 percent.[14]

As put into the ASEAN Smart Cities Network framework, smart cities in ASEAN can apply innovative solutions to enhance the overall welfare of their citizens and to address all of the above-mentioned issues.[15] Smart cities in ASEAN can invest in smart infrastructure to deliver multiple benefits across various stakeholders, whether private, public or corporate. These can include: (i) smart utilities such as energy, water and wastewater treatment; (ii) smart mobility and transportation; and (iii) smart buildings and construction.[16]

But What Is a Smart Building?

A smart building is one that uses automated processes to control the building's systems i.e. HVAC systems, lighting, electric devices, security systems etc. Smart buildings use automation to make a building grid flexible, healthy, productive, energy and cost efficient.

The most common definition of smart buildings focuses on the combination of energy-saving systems and intelligent technologies with the aim of finding a balance between comfort levels for occupants and energy consumption. The term also implies the ability of a system to operate autonomously from users and suggest, or to a certain degree perform actions. However, the intelligence of a modern smart home is considered to be, in addition to the degree of evolution and automation of a system, the degree to which its system serves the needs of a 'green' home (i.e., energy-saving mechanisms should be included in its operation). In any case, a smart building should contain energy efficiency mechanisms in its design, as well as adaptation or "training" mechanisms to adapts its operations parameters to the prevailing conditions. For example, by applying pre-selected scenarios or automation algorithms;and/or prediction of future operations-processes. To this end, it shall include energy saving systems that go beyond its intelligence. For example, a green building, which takes full advantage of the use of renewable energy in its operation with a practically zero balance sheet, may not be intelligent, but it is in fact 'smart' in the way it uses energy - something that a truly smart/intelligent building may not be able to achieve.

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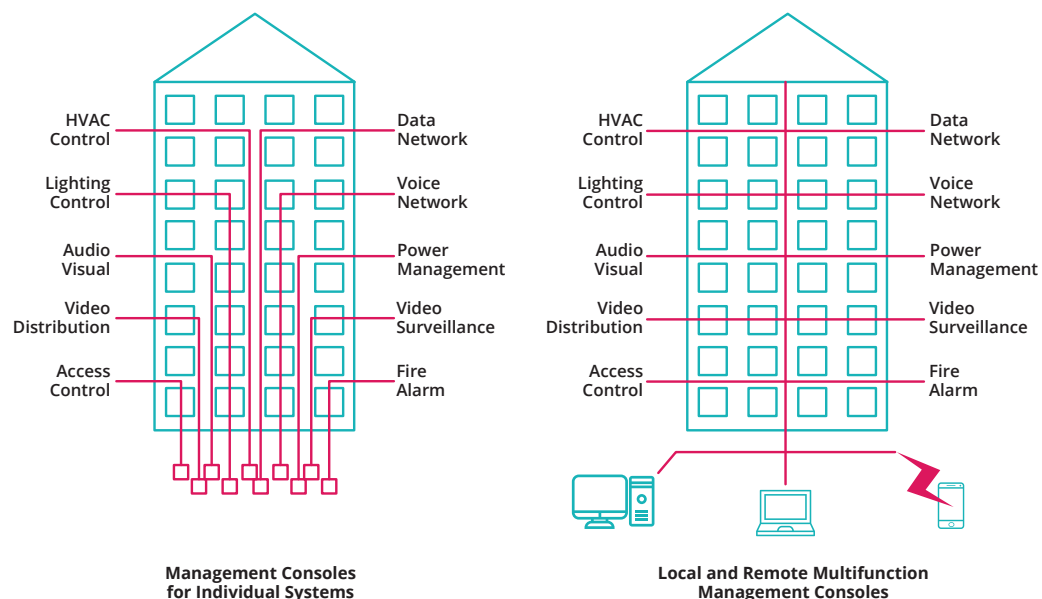
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Management Consoles for Individual Systems

Labels (left side): HVAC Control, Lighting Control, Audio Visual, Video Distribution, Access Control
Labels (right side): Data Network, Voice Network, Power Management, Video Surveillance, Fire Alarm

Local and Remote Multifunction Management Consoles

Labels (left side): HVAC Control, Lighting Control, Audio Visual, Video Distribution, Access Control
Labels (right side): Data Network, Voice Network, Power Management, Video Surveillance, Fire Alarm

In short, we can distinguish five levels of operation of a smart building. The smart building:

- Provides basic connectivity/communication (internet etc.).
- Responds to simple operation control commands inside or outside the home.
- Controls its operation from within or outside. Local or remote control can include various types of control (door opening and closing, control of windows - doors that are open, user control of lighting, etc.). The control depends on the level strictly on the user.
- Automated operation (lighting on/off at a predetermined interval, programmed operation of heating or cooling systems, security systems, etc.).
- Detects presence & health & safety parameters. The system operates or under-operates based on the human presence in a room or indications related to the optimal QoL of people.
- Information Analysis - Decision Making and Action. The system provides information on energy consumption to

one or more users, generates reports for residents, managers or providers, makes changes to automated functions (based on prescribed behaviours/options or algorithms that vary the system operation according to different parameters) in order to achieve optimal overall operation.

In addition to the above-mentioned functions, a smart home can provide other functionalities such as providing information, reminders and suggestions to the users relevant to their daily life and schedule, 'answer' their questions or act on behalf of them.

How Does Smart Building Technology Work?

One of the methods to make a building smart is the Building Energy Management Systems. A building energy management system (BEMS) is a way to monitor and control the building's energy needs, for instance energy data from heating, ventilation, and

air conditioning (HVAC) systems. Then, depending on the collected data, the system identifies the building's energy consumption patterns and creates more efficient energy consumption plans.[17]

According to Global Industry Analysts, Inc., Asia-Pacific ranks as the fastest-growing market for BEMS with an annual growth rate of almost 20 percent over the period analysed.[18] This reflects the growing need for such systems by developers and governments. All this leads to increasing opportunities for collaboration between technology companies and energy stakeholders to drive smart transformation in the region.

The main necessary step towards both a smart city and smart transformation is data. For such a development data cannot be considered as costly or redundant. Instead, they must be viewed as a necessary source of information for any level of planning. Cities with lower capacities could kick-start their strategy development by creating open portals that make raw data available to the public, and which the private sector could use to develop innovative smart solutions. Urban planners should should also raise awareness of the sources of this data, as well as the global innovations they feel could be applied to their own cities. This requires minimal public investment but could serve to improve the quality of life for citizens in the long run.[19] Moreover, lower budget cities should prioritise practical technologies over high-end, 'trendy' ones.

Smart Devices

A way to acquire building and city data are smart devices, which are electronic devices that have the ability to connect to other devices or (intelligent) networks via different protocols (Bluetooth, NFC, Wi-Fi, 3G) and can operate to a certain extent interactively and autonomously. These devices will in the long term replace conventional household appliances as a key feature of 'smart homes'. Smart technologies are also a major factor in shaping what is called the Internet of Things. The term 'smart device' can even refer to a technologically advanced computing device that has advanced capabilities and/or elements of AI. The basic idea behind smart devices is the ability to provide the user to operate them locally or remotely via wireless communication.

Smart appliances fulfil the objective of home building automation by having a sufficient (or high) degree of independence from the user and a minimum (or maximum) degree of intelligence. For example, an automated building ventilation system can monitor the amount of carbon dioxide (CO_2) and can vary the amount of airflow in occupied areas without over-ventilating others, saving considerable energy in HVAC operations. Additionally, home automation systems are defined and can optimize airflow by parameters like occupancy, temperature, humidity, pressure, air quality and ventilation.[20] The system monitors this data via sensors then a microprocessor device analyses it and forwards it to a control device.[21]

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18. AIBP Industry Platform, *How Smart Energy Management Systems Can Drive Transformation in ASEAN Countries Industry Platform*, https://iotbusiness-platform.com/insights/how-smart-energy-management-systems-can-drive-transformation-in-asean-countries/.

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Typical home automation has a set of sensors, an actuator, a control panel and a main-board with a microcontroller, moreover there is communication protocol between these components of the system.[22] The performance of home automation systems can be enhanced by using data loggers. A data logger is a data collecting and saving tool which allows for further analysis of related environmental changes. Data loggers are capable of recording time stamped data from a data source, a home automation system, and saving them into a data storage server or an internal memory.[23] Therefore, it is possible to add a data logger component to an existing home automation system. The data collected by the data logger can then be analysed for the desired goal, such as energy efficiency, health, or optimal ventilation system function.[24]

Towards Smart Buildings and Better Quality of Life in Phnom Penh

Due to the hot and humid tropical climate in Southeast Asian countries, a relatively large share of energy consumption is attributed to air conditioning used to maintain occupant thermal comfort. Reducing building energy consumption while maintaining comfort is a regional societal challenge tied to sustainable urban development and QoL maintenance in the region.

QoL in Phnom Penh is the focus of the Build4People research project and the relation of comfort to building energy use is one of the project's core considerations.[25] For that, basic indoor environmental parameters (temperature, humidity, CO2-concentration) in residential buildings are continuously monitored with wireless data loggers over a six-month period. Moreover, weather data is gathered from the National Centre for Environmental Information website and from the project's weather stations.

More specifically a series of surveys and studies are conducted in Phnom Penh within the project in order to try to answer how indoor environmental quality can be evaluated, measured and enhanced, both on the user and building level in the specific context of Phnom Penh.[26] Comprehensive indoor environmental data and occupant behaviour information are collected, analysed and used as a basis for subsequent simulation studies. The whole survey campaign consists of four main parts: preliminary household survey, building audit and long-term monitoring, detailed on-site survey and thermal comfort survey with occupants. The collected data are analysed, processed and prepared for following research and development of climate-adapted building strategies.

The purpose of this measurement campaign is to gain a basic understanding of the residential usage, building thermal behaviour, function, energy consumption, and perceived quality of life in Phnom Penh's urban regions. By identifying the link between occupant behaviour, building controls, energy-related consumption patterns and buildings thermal behaviour, innovations for building technology adoption

in the building sector can be suggested and evaluated.[27]

The results of these combined campaigns can then be used to evaluate the impact of the use of different building materials, design techniques and user behaviour to the Indoor Environmental Quality (IEQ) in residential buildings and to possible energy savings. For existing buildings, building audits and records are critical for understanding what needs to be done, and when, to improve efficiency, intelligence and the occupants QoL. By following a series of core steps (understanding, measurement, enhancement), these outcomes can be used to promote and support the development of sustainable and smart building codes, guidelines and policies.

The first step towards any kind of smart intervention is the understanding of the current status of the building stock and how it can be optimised. Apart from helping us to gain this understanding, the use of specific data loggers could be also considered as a step towards smart devices in building monitoring, since the user can have access to the information in real time and make adjustments towards improving air quality, thermal comfort and energy use. The overall campaign could be used as a preparatory stage for a smart building design strategy by the city of Phnom Penh and could be aligned with the governments drafted plans to transform key Cambodian cities, with Phnom Penh amongst them, into smart cities, aiming at establishing an inclusive ASEAN smart cities network.[28]

Long-term measurements of the indoor environmental conditions should be used to identify solutions other than those revealed by the audit's data. This already qualifies as an entry level smart technology, especially if the equipment is connected to the Wi-Fi and other platforms providing real time information. The impact of the various components of the building depends a lot on the local conditions, thus the fundamental principles of smart buildings will differ in the various climates, meaning that the specific climate conditions of Phnom Penh should be taken into consideration.

It is also evident that some of the available technologies might currently not be economically feasible and that the local market capacities might not be enough to implement such solutions. In order to take into account these technologies and the predicted changes, the methodology of a technology roadmap can be employed. Such a roadmap documents the current context and drafts the desired future performance, then develops a pathway from the current situation towards the intended future performance.[29] Therefore, a roadmap for smart buildings can be made using the data acquired in the earlier processes by identifying current and emerging technologies as well as other advancements that can assist in achieving the desired future scenarios.[30]

Benefits of Smart Buildings

If smart-building solutions are applied in commercial and residential buildings,

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30. Hannah Kosow, Robert Gaßner, Lorenz Erdmann, *Methoden der Zukunfts- und Szenarioanalyse, Überblick, Bewertung und Auswahlkriterien*, Berlin, IZT, 2008

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they can make them safer and healthier. Safer due to the improved fire, security and other emergency procedures that can be tracked instantly and healthier due to the technology's ability to monitor and control the indoor environmental conditions. Smart technologies can monitor factors such as air quality and water quality and can notify the users instantly when value thresholds are surpassed. For instance, an automated system can increase ventilation when the CO_2 levels increase above a set level in a room.

Automated operations can be employed in residential buildings to regulate energy usage in accordance with user demand and to instantly inform inhabitants about their energy use. Energy efficiency improvements result in lower emissions and less demand for resources. For instance, turning AC units off later at night when people are sleeping and/or controlling AC to necessary temperatures based on adaptive comfort models, can save energy and promote better sleep.[31] Moreover, residents can change energy use behaviour according to the provided information while the system can apply certain comfort settings for the residents based on the prevailing climatic conditions (Image 2).
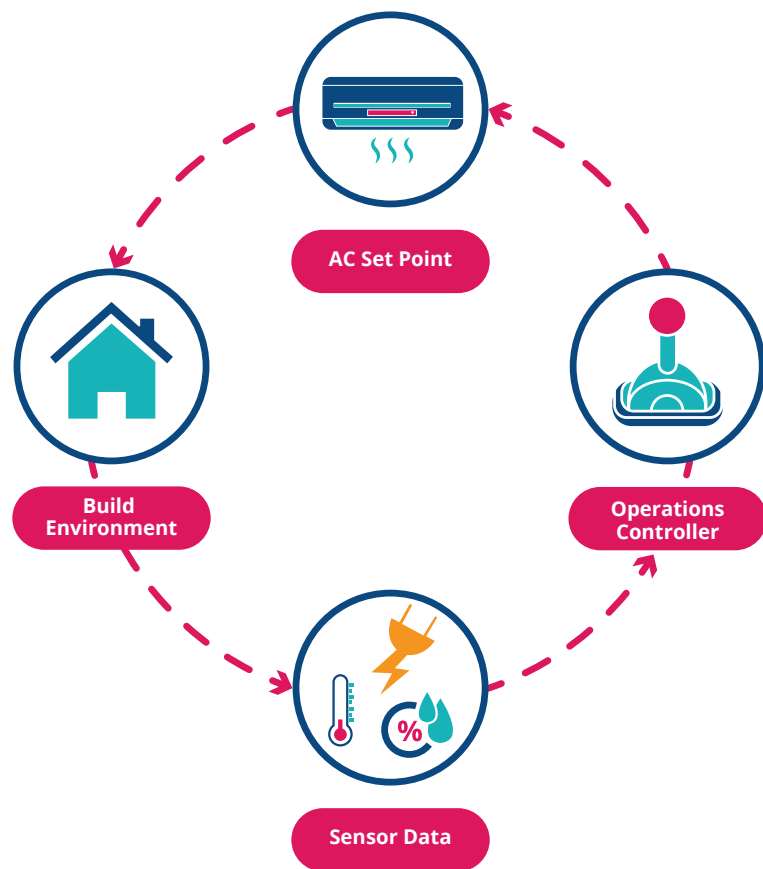
Energy-Efficient Thermal Comfort Control in Smart Buildings

A prevalent problem in residential buildings in countries like Cambodia or Vietnam is the low air quality, where poor, inefficient HVAC systems are used to cool rooms. Furthermore, due to a lack of awareness of natural ventilation, many people open windows while operating their air conditioning units, thus wasting energy. If the functioning of the AC, window openings, and mechanical ventilation are connected, smart technology can assist in resolving the issue between the supply of fresh air and the AC. For example, simple sensors on windows and doors can be used to lock AC operation, or ventilation can be managed to maintain CO_2 and humidity levels below necessary thresholds via natural but controlled air exchange if the windows or ventilation apertures are fitted with motorized shutters.

Cambodian buildings are exposed to a lot of sunlight, 8 hours per day of intense sunlight to be specific. Without thoughtfully planned open spaces or natural air movement included into urban design, this contributes to overheating and the excessive usage of air conditioning equipment. One of the most widely used strategies to avoid solar radiation in buildings is to provide appropriate shading. On the other hand, external shading devices might be compromised by storms during the rainy season (especially in high rise buildings). In this situation, smart control can be used to make the most of external shade devices and safeguard them from wind sensor damage.

Another application of smart technology with obvious benefits is the coordination of household energy consumers, such as washing machines or electric water heaters, with renewable energy supply from Photovoltaic (PV) systems installed on the roof. Thereby the benefit of renewable energy applications is maximized and the demand for battery storage is reduced.

Conclusion

For buildings to be considered smart, they must first be sustainable and energy-efficient. Policy makers and frontrunners should push for subsidised energy efficiency and building retrofit schemes, as well as smart technologies such as smart meters.

For such schemes and technologies to work, the lack of good quality data, caused by poor data acquisition and sharing practices, needs to be addressed as soon as possible. Data should be first acquired and then become openly accessible so they can be linked to other useful datasets. In order for buildings to be smart and for their energy use to be aligned to the grid, such data needs to be accessible in real time, of course with maintained privacy at all times. User-building and energy interactions should be carefully considered when new technologies are integrated into buildings. This integration should happen gradually, starting with simple technologies where the user can have an understanding of the interaction and where there is feedback between the building and its users. Furthermore, the concerns of homeowners will be alleviated if they can see the benefits and use of their data, so raising public awareness should be put on the first line of a data acquisition campaign.

Reducing energy demand and decarbonising buildings and energy systems is a complex problem with a range of socio-economic and technological aspects. Smart sensors and energy monitoring coupled with user input can help provide solutions for different kinds of inefficient building or user behaviours. The analysis of the acquired data can help identify and provide solutions for balancing demand and supply. In turn, It can reduce our overall reliance on fossil fuels, and lead to the promotion of more environmentally

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friendly energy sources. Smart technologies can reduce emissions with additional health-related benefits.

In conclusion, smart technologies can reduce emissions with additional health-related benefits. The potential is enormous and should be explored in all aspects, particularly in climatic zones requiring year-round cooling - such as Cambodia.

Acknowledgements

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PHNOM PENH'S RETAIL PLANNING AND DEVELOPMENTS IN THE EXISTING AND NEW URBAN COMMUNITIES

ERIC WONG

The future of physical retail stores will depend on how well retailers can connect more with customers on a personal level. It can be through smart technologies, or to engage in retail strategy planning. Within the constantly evolving world of smart cities, the retail vision of Phnom Penh should be built from the need to create more personalized experiences for the customers, create a positive retail environment in order to pave the way to upgrade the overall retail experiences in this city

Introduction

Traditionally, the only building type in Phnom Penh serving as both residence and commercial business is the shophouse.[1] These shophouses are mostly two or three stories high, with ground floor served for mercantile activities and residence above the shop.[2] Over the past decade, more and more of us have moved away from living in the core centre of Phnom Penh as new housing developments have been created elsewhere. With the growing number of satellite cities and residential communities (boreys) scattering the outskirts of Phnom Penh, there are developments with thousands of flats and houses but with no retail proposition to speak of. Developers must know the importance of creating a community that is not just a place to work, or to go home, but a sanctuary where one can have a well-rounded lifestyle. This is why incorporating amenities - to offer convenience so residents won't have to travel far from home for their daily errands. For example, commercial establishments where residents can find eateries, laundry, mini-groceries, laundry and more.

How E-Commerce Is Redefining the Retail Industry

The convenience of e-commerce, combined with the change in consumer behaviour globally, reflects a stronger demand for online shopping where consumers turned to their devices for their grocery, apparel, and home furnishing purchases.[3] However, if everyone started doing all their shopping online, all the retail stores would go out of business.[4] When all the stores are gone, we'll have to drive further and further away to shop at a real store. Some people may have already experienced the negative and the devastating impacts of e-commerce. Furthermore, if you do all your business online, you'll never have to leave your home. This might be great for a while, sometimes you might want to go outside to breathe some fresh air, get a change of scenery, talk to real people, or participate in your community to be a part of the real human connection.

Most people prefer to visit stores for an experience they can't achieve online - to feel the products, to try them on, or to get a better idea of the product or service.[5] On the other hand, shoppers want to be inspired by the in-store experience and to take their time exploring different products or services in a beautiful setting.

The retail industry is going through major upheaval - the growing market for walkable

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5. Erick Li, Qiang Lu and Masoud Talebian, "Online versus bricks-and-mortar retailing: a comparison of price, assortment and delivery time"

urbanism.[6] Many cities have moved away from traditional street commerce, to the idea of shopping districts that have a mix of walking streets and retail malls. In Phnom Penh, the number of new retail malls grew exponentially each year which has totally changed how people shop and dine out. With more malls popping up, retail footfall and sales are expected to be affected as competition grows. Furthermore, the growth of retail malls is also taking customers away from street commerce. This really needs to be addressed by the local authorities.

At the same time, existing retailers in the shophouses have been hit by a combination of issues - lack of parking spaces,[7] competition from online shops and the rise of retail malls. The difference is independent businesses may want to surround themselves with other independent shops, and established corporate brands tend to prefer to set up at retail malls. Certain chain retailers have reduced the size of their store portfolios due to high rentals (as they step away from retail malls due to poor returns on rental costs), they can seize the opportunity to occupy retail spaces along the high streets. At the same time, spending at a local business rather than a chain store will keep more money in the local economy, as local establishments source more of their own supplies and services locally.

Promoting Vibrant Street Commerce

In many developing countries including Cambodia, the bulk of urban retail activities continues to take place on the street, even as new car-oriented retail malls are on the rise. As a result, developers need to evolve and take a look at street commerce with a fresh set of eyes. High street is a retail and commercial-based stretch of road (sometimes fully or partially pedestrianised), commonly found in most cities in Australia, UK or other Commonwealth nations. Indeed, the pride a resident feels for their city is often linked to the vibrancy of its high streets. While the retail and leisure failures might suggest that street commerce does not have a future elsewhere,[8] I would argue the opposite. In our borey developments, high streets in the shophouse formats can be a place for people looking to shop and socialise,[9] as residents are still likely to prioritise local convenience if they think they can find what they need. If people continue to support these stores, their businesses will undoubtedly see continued high levels of footfall. Clearly, there are still gaps across the idea of street commerce, but these are also opportunities. Finding retail space was once a barrier to entry for businesses in Phnom Penh, but this is one hurdle that is now much easier to overcome. Innovative businesses with a vision for a better shopping experience now have a chance to set up in the shophouse. However, these physical stores must offer a better experience. For example, the need to go beyond shopping and entertainment, to include medical and other services, jobs, education and physical activities also need to be taken into consideration.

High Street Retail: Why It Is Better Than a Mall

In my opinion, it would be the street commerce rather than retail malls that would prove most resilient in the long run, and lively shopping areas do more than provide access to goods and services. It can be the civic and social spaces where people mingle and gain access to opportunities, and diverse sets of people can encounter each other. First of all, shophouses lead to increased footfall from people who can't or don't want to drive. Sevtsuk notes: "The more errands and social activities we can complete without having to drive, the more sustainable and energy-efficient our cities will be."[10] If there are other supporting attractions, this can help to pull increased numbers of visitors into the stores. Developers and property managers can also host events targeted at the store owners and residents to create a sense of community.

Does the High Street Have a Future with the Changing Geographies of Retail?

To create a new high street, the early development of a strong tenant line-up is particularly crucial as these streets endeavour to establish their market position and image. Consumers these days are bored of the homogenous and generic offering. For example, having multiple groceries in close proximity rarely works as they will compete with each other. However, some thriving clusters do feature businesses that compete with each other,[11] where proximity gives customers more choice and thereby attracts a larger clientele. Antique stores, bookstores, clothing stores or restaurants, are often found shoulder to shoulder in competitive clusters that make all stores better off. Presentation is really important on a shop by shop basis, and some tenants simply don't understand how to apply sufficient focus to the 'visual' aspects of their retailing. One poorly presented shop can impact other shops in the same cluster. To some degree developers or property managers have to closely monitor their shop layout and presentation across the tenant mix - taking care of the tenant community and ongoing operations.[12] Any frustrations within the tenancy mix will produce problems, so it is wise to keep in close contact with all the tenants. Meeting with the tenants in a regular way will help the developer see those upcoming problems and prevent them getting out of control. It is important to note that not all tenants in occupancy will integrate well with others surrounding them. Hence, a good degree of knowledge and a lot of systems are required to successfully manage street commerce. Many mall-owners or property developers (developers without a retail experience to be precise) don't attract the right consumers as they don't have the right tenant mix or ambiance to run their retail premises.[13]

Understanding Street Commerce Performance

To ensure the successful operations of street commerce, the retail areas and entrances must be well-maintained and inviting, creating a sense of well-being. The lettings management has to look for brands and retail concepts matching to the property, this includes looking into the consumer preferences and requirements as well as

6. Peter Dizikies, "How to help urban street commerce thrive" *Massachusetts Institute of Technology*, 28 Aug. 2020, Access 10 Apr. 2022 https://news.mit.edu/2020/street-commerce-urban-book-0828

7. Owen Gough, "Most Brits would use the high street more if free parking was offered" Small Business, 28 Jul. 2017, Access 22 Apr. 2022 https://smallbusiness.co.uk/high-street-free-parking-2539934

8. Bill Grimsey, "The Grimsey Review: An alternative future for the high street" *The Grimsey Review* Sep. 2013, Access 25 Apr. 2022 https://britishbids.info/publications/the-grimsey-review

9. Bill Grimsey, "The Grimsey Review: An alternative future for the high street"

10. Peter Dizikies "How to help urban street commerce thrive"

11. Anthony Breach and Rebecca McDonald, "Building Blocks: The role of commercial space in Local Industrial Strategies" Centre for Cities, 26 Jun. 2018, Access 20 Apr. 2022 https://cdn.britishbids.info/publications/centre-for-cities_building-blocks-research-report2018.pdf?mtime=20180719083601

12. Animesh T, "How to Manage Retail Tenant Mix?: Mall Management." *Your Article Library*, 26 Jul. 2016, Access 18 Apr. 2022 https://www.yourarticlelibrary.com/mall-management/tenant-mix/how-to-manage-retail-tenant-mix-mall-management/87360

13. Animesh T, "How to Manage Retail Tenant Mix?: Mall Management."

changes in shopping behaviour. One of the more revolutionary and promising concepts is adding live/work alternatives for the residents. Among the answers to the above question are dining experiences, beyond the ubiquitous eateries, adding hotel and office space components in the high streets, and other services, such as dry cleaners, salons and barber shops, fitness and other workouts centers, or adding recreational activities to support the high streets, such as rock climbing, children's activities, even indoor water parks and amusement parks, and medical care uses.[14]

Improving the Vitality of Street Commerce

While a person may head to high street specifically to buy one item, they may be encouraged to make additional purchases from other businesses as they travel along - a well-known brand along the high street is always visible to a passer-by. Make sure it offers conveniences for residents. There will always be lots of places to eat, or more flexibility in terms of the space available in terms of layout plans. Developers have to push the boundaries beyond retail to create a community that becomes destinations where guests or residents can meet, eat, be entertained, and shop. Conversely, tenants in the high streets can also face negatives by the residential communities, not the least of which is being surrounded by commercial use spaces and perhaps the crowds they draw. For example, some restaurants may create noise, gyms may play loud music, so soundproofing must be considered in the buildout of a space depending upon the use.

The commercial ecosystems featured are fragile and sensitive to change. Moreover, the perceived weaknesses of the high street model, such as the fragmented ownership and lack of centralised coordination etc. The fragmented ownership of the high street shops, with a high proportion of small independent landlords that cannot afford the costs of vacant[15] properties will reduce the barriers to entry for small businesses seeking to test new concepts. In Cambodia, where high streets are not as developed, rentals in high streets are more affordable than retail malls. Therefore, retailers offering a richer consumer experience will continue to thrive under the roof of street commerce instead of vanishing,[16] as exclusive stores would continue to grow with the help of loyal customers.

In addition, developers or property managers will need to look at the permitted use that applies to each tenant lease, and then make sure that each tenant stays within the guidelines or limitations. For any retail developments, a successful tenant mix needs to respond to such changes requiring "continuous monitoring, evaluation and action on the part of the manager."[17]

Using Technology to Enhance Street Commerce and Revealing the Importance of Amenity-Oriented Development

Afterall, people still need the emotional satisfaction of real-life shopping experience. In terms of online sales, digital and physical

experiences will simply merge into each other.[18] For many, digital shopping is creating more pathways to success. Perhaps the most obvious impact of digital shopping is on the revenues and profitability of the retailer.[19] This is a trend that the market does not expect to change, and given the fact that street commerce in its most traditional sense might be dead. But in combination with new technologies, this gave birth to a completely new experience for the retailers. One of the main benefits of street commerce is that residents will have restaurants, services and retail at their front door step. The close proximity to these uses will allow the consumer to utilize these almost as the amenities. These commercial tenants will also find a new captive audience for their goods and services. The main purpose of street commerce is to connect with the local community and provide them with convenience, engagement, experiences and choice. For that reason, amenity-oriented development should be a widely accepted model for developers to capture the social, economic, and environmental benefits that vibrant street commerce has to offer.

Benefits of Street Commerce for Consumers / Retailers

In the end, a retailer's decision whether to set up in a high street will depend on various factors such as location, footfalls and the nature of product or service they are selling. While a retail mall may give you a lot of footfall, conversions are higher on high street. High street offers better customisation and personalised experience. but it has to

adapt to the new retail landscape and attune themselves to the evolving trends.

Conclusion

I believe the idea of street commerce remains a vital part of the purchasing process, and the shopping experience needs to be changed to keep attracting people back to a tailor-made destination. The majority of retail and F&B sales today do still take place in physical stores as the customers still value good advice from in-store advisors. In addition, the relationship between developers, landlords and tenants will need to be redesigned to ensure long-term and sustainable business relationships. This will require sensitive and constructive support from the planning regime, urban design principles, regulatory policies, and merchant organization models etc. to enable the equilibrium between supply and demand to be re-established. The recovery of street commerce will be patchy and the mix of uses will differ widely from place to place.[20] The end goal is to develop a loyalty to local businesses, as customers would be more likely to spend with what they are comfortable with. As a result, street commerce should not be written off just yet. It does indeed have an exciting future and successful street commerce can only be achieved with private sector, urban policy makers, planners, and the public – all stakeholders equipped with the relevant knowledge and tools to plan and regulate it.

20. Animesh T, "How to Manage Retail Tenant Mix?: Mall Management."

14. Akrur Barua and Daniel Bachman, "The consumer rush to "experience": Truth or fallacy?" *Deloitte Insights,* 18 Aug. 2017, Access 18 Apr. 2022 https://www2.deloitte.com/us/en/insights/economy/behind-the-numbers/are-consumers-spending-more-on-experience.html

15. Simon Creasey, "The Belgian city showing how high street regeneration should be done" *Property Week,* 8 Mar. 2019, Access 20 Apr. 2022 https://www.propertyweek.com/features/the-belgian-cityshowing-how-high-street-regeneration-should-be-done/5101748.article

16. Simon Jenkins, "Why high streets don't need shops to survive"

17. Animesh T, "How to Manage Retail Tenant Mix?: Mall Management."

18. Erick Li, Qiang Lu and Masoud Talebian, "Online versus bricks-and-mortar retailing: a comparison of price, assortment and delivery time"

19. Bill Grimsey, Matthew Hopkinson, Nick Hood, Eva Pascoe, Chris Shellard, Jackie Sadek, Kim Cassidy, Vanessa Dehullu and Matt Baker, "The Grimsey Review 2" *The Grimsey Review 2* Jul. 2018, Access 25 Apr. 2022 http://www.vanishinghighstreet.com/wp-content/uploads/2018/07/GrimseyReview2_new1.pdf

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URBAN TRANSPORTATION

DIGITAL INSIGHTS: FUTURE OF CITIES

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PUBLIC TRANSPORT AS A CATALYST FOR AN EGALITARIAN SOCIETY AND SUSTAINABLE FUTURE

UNG TECHHONG LUY   J. CORBETT HIX

Phnom Penh — Present Reality and Future Headaches

Phnom Penh is at a crossroads between unfettered growth at all costs and quality of life for its residents. The development over the past ten years has traveled at breakneck speed, a result of pent-up demand from the post-conflict period and a decade of finding its feet and stabilization. The improvements in public health, access to electricity, clean water or better-paying jobs, and a thriving economy are worthy of praise but the rapid economic and related increases in urbanization have come with many unpaid costs.

The average speed of vehicles has decreased from 20km/h to 15km/h while large influxes of foreign capital have distorted the property and housing markets, pushing the lower-income and middle class further to the periphery of the city.[1] The entire country has benefitted from growth in numerous ways, but it has also negatively impacted the quality of life for many city dwellers and begun to stratify society according to socioeconomic status, impairing already weak social capital and trust amongst the city's residents.

Middle-class children no longer walk to their local public schools but instead are scattered across the city with no connection to amenities and daily necessities, adding additional pressure on roads. Lower-income people, for decades, have rushed to buy motorbikes, second-hand cars, or, when possible, the largest SUVs they can find in an effort to announce to the world that they have "made it". Meanwhile, cars take the space of six motorbikes on the road while having nowhere to park in the city center other than what were once sidewalks. This forces those who choose to walk into the streets, where all drivers navigate with abandon and where the driving force seems to be 'only I matter'. Cars and motorbikes fill, filling every crevice between vehicles and barges through intersections, causing longer traffic jams.

Pedestrians have arguably gotten the worst end of the stick. Those who might have walked two blocks to their local markets now feel threatened on foot, forcing them to get on their motorbike or car. Children are the most at risk, attempting to play in the street because they have few if any, outdoor alternatives. They simply stay inside, attached to screens rather than neighborhood friends.

Things do not need to be this way, but unless there is rapid action, it could be too late. Phnom Penh may have sealed its path towards becoming the next mini-Jakarta or Manila — a self-contained parking lot that most residents look forward to only leaving. If the projections are right, Phnom Penh is on its way to housing more than 2.4 million people in 2030, most of whom might share the same aspiration of owning a car and motorbike adding additional stress on the infrastructure.[2] Most will not consider the idea of public transport as their daily transportation mode because it is slow, unreliable, stuck in the same traffic or simply, does not exist.

The Emergence of Conspicuous Consumerism and Its Contrast with Buddhism

Seeing the prosperity that Cambodia is experiencing through capitalistic

1. "The Preparatory Survey For Project Of Development Of Traffic Management System In Phnom Penh," January 2015.

2. The Statistics Bureau of Japan. "Population Projections For Cambodia, 2008-2030." Accessed May 5, 2022. https://www.stat.go.jp/info/meetings/cambodia/pdf/rp12_ch10.pdf.

mechanisms over the past decades, it is hard to imagine that its people were once forced to abandon that same ideology. As Cambodia reached a lower-middle-income status in 2015, consumerism boomed with economic growth. Malls filled with branded designer items and luxury car showrooms sprouted throughout the capital. The new emerging middle-class and the wealthy embraced conspicuous consumerism as a way to show their peers, and the world, that they had shaken off the country's history and "succeeded" by flaunting their success publicly.

While it can be easy to jump on the bandwagon and call conspicuous consumerism a "Khmer thing", a global online survey by Ipsos suggests otherwise. It concluded that those in developing countries are more likely to see themselves as materialistic than their Western counterparts, thus what is seen in Cambodia is not a phenomenon unique to the country but common in others.[3]

Around 95 percent of Cambodians are Buddhist but many contemporary actions have strayed away from the teachings of Theravada Buddhism. Our current society is heavily materialistic, corrupting fundamental values that unify a society. Materialism also damages the individual. Findings in Psychological Science show that materialistic individuals tend to have low levels of well-being.[4] Maybe it is time for us to review our lessons on Buddhism. Buddha taught us to gain satisfaction through the tranquility of the mind and a deeper understanding of oneself, which leads to enlightenment and deliverance, setting one free of any social norms or pressures.[5] This is the opposite of a materialist society.

Geographic and Economic Walls — How We Live Apart, From Gated Communities to the Rest

Cambodian society is stratified not only by values but also by the economic, geographic, and, increasingly, physical walls. While attempting to safeguard the privileged, impacts are felt the most by the less privileged. Gated boreys are increasingly where the emerging middle class aspires to be. These range from affordable options on the far perimeter of the city, to mid-range developments such as New World (Piphup Thmey) and options such as Peng Huoth, Chip Mong, or Phnom Penh Thmey for those able to leap into the upper class. Again, this phenomenon is not unique to Cambodia. Suburban master-planned communities redefined life in post-World War II America, orienting new communities around economic and racial segregation, and dependency on personal transport. They offered middle-class Americans an alternative to overcrowded cities, small apartments, and the chaos of the city center. Providing "safer" neighborhoods with private access to a variety of amenities like parks, schools, fitness centers, golf clubs, shopping malls, and other accouterments of middle-class life.

Cambodia is in the midst of a similar post-war real estate boom. CBRE (real estate and real estate analysis firm) found that there were only 77 borey projects a decade ago, but the number has since quadrupled.[6] One might be excited by the numbers, more housing development is better for the whole city, right? Not necessarily—

boreys, like American suburbs, encourage social and residential segregation, causing friction in society. Those who live in gated communities are isolated and less likely to participate in local community events, losing the opportunity to interact with people of different socioeconomic statuses.[7] Like U.S. suburbs, they are built entirely reliant on cars for access, segregated by economic access, and limiting mobility to youth and those without vehicles to connections to the larger city.

The current approach to urban design parallels the story of Buddha's childhood. The father-king did not want his son, Buddha, to see the outside world that is filled with suffering and imperfection. He tried to keep his son behind the palace's gate for as long as he could. Here, the preference for highly controlled, exclusionary housing prevents people of different backgrounds from interacting and knowing each other. Open spaces in these developments are available only to residents, and are not public, they are available only to those who can afford to pay the borey premium.

We would like to see a shift toward a more egalitarian society. If we are to get better as a society, we must encourage and empower Cambodians to think of inclusiveness and not exclusiveness. The government, city planners, borey owners, and homebuyers, should rethink the fundamental values of a home and community, and understand how a common space where people of all ages, genders, and socioeconomic statuses can meet, talk, discuss, argue or simply, have fun, without feeling they might not belong. One only needs to look at the lessons from Buddha, or the social polarization in the United States.

Reclaiming Our Streets — Utilizing Public Transport to Strengthen Social Capital and Strong Communities

Transportation methods similarly divide society. Cars and motorbikes have become the primary transport modes for many. Nearly a million cars and more than 5 million motorbikes are currently on the streets of Cambodia today, an alarming number that makes traffic gridlocks occur more often.[8] This is understandable given how few choices Phnom Penh citizens have. Phnom Penh implemented a rollout of a public bus system in 2014 after two pilots in 2001 and 2014. At 2,000 Riels, the price is affordable compared to other modes of transport like ride-hailing. However, the quality of the service in both reliability and geographic reach is a common rider's complaint. Ridership also suffers from limited first and last-mile access.[9] Buses are also constrained by a lack of dedicated lanes, leaving riders in the same traffic that they hoped to avoid, now caught in larger vehicles that make frequent stops. This has impacted ridership and the financial sustainability of the whole bus operation.[10] The lack of a faster mode of transport impacts the livelihood of the whole city. Precious time that could be spent on family bonding or leisure activities is spent on work-to-home

3. "Global Attitudes on Materialism, Finances and Family - Ipsos." Accessed May 5, 2022. https://www.ipsos.com/en-us/news-polls/global-attitudes-materialism-finances-and-family.

4. Bauer, M. A., Wilkie, J. E., Kim, J. K., & Bodenhausen, G. V. (2012). Cuing Consumerism: Situational Materialism Undermines Personal and Social Well-Being. Psychological Science, 23(5), 517–523. https://doi.org/10.1177/0956797611429579

5. Dr. G. P. Malalasekera. "Aspects of Reality as Taught by Theravada Buddhism," 1968.

6. "2021 Fearless Forecast: Recession or Resurgence." CBRE Cambodia, 2021.

7. Deng, Feng. "Gated Community and Residential Segregation in Urban China." GeoJournal 82, no. 2 (2017): 231–46. http://www.jstor.org/stable/44202497.

8. Sen David. "Number of Registered Vehicles Increase ." Khmer Times - Insight into Cambodia, December 7, 2021. https://www.khmertimeskh.com/50983747/number-of-registered-vehicles-increase/.

9. First and last mile refer to options to getting to and from bus routes from initiation point (home/office) or final destination. Walking could be an option up to 1KM, but sidewalks and safe routes are absent; bicycles are unrealistic unless safe bicycle parking were provided.

10. Meta, Kong. "As Phnom Penh Students Embraced Public Buses, the Pandemic Brought the Service to an Abrupt Stop." Cambodian Journalists Alliance, February 16, 2021. https://cambojanews.com/as-phnom-penh-students-embraced-public-buses-the-pandemic-brought-the-service-to-an-abrupt-stop/#:~:text=A%202020%20report%20from%20the,a%20day%20across%20the%20city.

commutes which may result in rising blood pressure and stress among drivers who encounter unethical driving behaviors that are inevitable during rush hours. While on the road, personal vehicle owners contribute to the worsening climate and air quality by polluting the air with idling engines. Vehicle noise and chaotic honking contribute to the underrated effects of noise pollution on people who live right next to the streets.[11]

"The automobile age promised freedom and self-fulfillment, but it has actually imprisoned us, impoverished us, and eroded our communities. The demand for oil is fast outpacing the world's supply, and it is time to start imagining a world after the automobile age." - Taras Grescoe, Straphanger: Saving Our Cities and Ourselves from the Automobile

Public transport is the obvious way forward if we are to ensure that Phnom Penh is livable in the future. We do not need to jump to subways, sky trains, or expensive high-speed trains immediately; those projects take a significant amount of time to plan, fund, and implement.[12] COVID-19 put a stop to the rising public bus ridership of mostly high school students and young adults. But now that the pandemic has subsided, the government, especially the PPCH (Phnom Penh City Hall) and CBA (City Bus Authority) should improve the time and route availability of the public bus while also creating a campaign to promote its usage and benefits.[13]

There is evidence around the world that public transportation increases the livability of a city. Faced with a similar post-conflict and rapid economic growth, Bogotá, Colombia is an appropriate comparison for Phnom Penh. Two decades ago, a progressive mayor, unafraid to rattle the elite, introduced TransMilenio, which is now hailed as one of the most successful bus systems in the world.[14] Operated on dedicated bus lanes with platforms for ticketing, waiting and boarding (up to 160 people), it operates more like an above-ground subway, but at a fraction of the cost, moving 1.7 million people per day, simultaneously being only 1 of 2 systems in the world that turn a profit (the other is Japan).[15] Bogota offers a paragon of courageous leadership, transforming the city from one of the most congested, to one built for people by providing cost-effective mass transportation that helps the majority, all in the space of ten years. Phnom Penh could do the same if its leadership is willing to take bold steps in favor of the greater good.

"An advanced city is not one where even the poor use cars, but rather one where even the rich use public transport," - Enrique Peñalosa, Former Mayor of Bogotá, Colombia

Walking as Transport

Often overlooked, walking is also a form of public transport. Walking is the ideal distance for 100m - 800m distances but is dependent on safe public sidewalks and some degree of shade in hot climates. However, Phnom Penh sidewalks have been overtaken by street vendors, cars, and motorbikes who have completely repurposed them, forcing pedestrians into unsafe streets. This leads to many trips (like visiting a local market) that

could be done by walking, to be done on motorbike or car. Reclaiming the sidewalks for safe use by pedestrians is a win, win, win strategy — it is a low-cost intervention that will improve health, happiness, and safety while helping to reduce traffic congestion. Similar to declaring some street lanes exclusively for buses, the leadership needs to be willing to upset both the car-and-moto-owning class who currently use them for parking and street vendors whose operations and seatings push pedestrians into the street. These are surmountable problems if the community can voice their opinions for leaders to listen and act. If pedestrian sidewalks are made safe again, thousands of daily unnecessary vehicle trips could be taken off city streets.

Prioritizing the Right Investments

In sum, we argue that investments in public transportation, with an emphasis on walking (as a form of transport) and rapid-bus transit, can potentially recover the "charm" of Phnom Penh as an exciting city to visit and help alleviate the growing social stratification. We need municipal reform that allows for more autonomy and budgetary control at the local level, and leadership that is bold enough to propose policies that might upset the car-owning class. Phnom Penh currently generates 70 percent of the government's tax revenue, but these investments are spread across the entire country. The split management of the city between the Board of Governors and Ministry of Interior, with little to no input at lower levels on policy matters or budgetary control, prevents full execution of any of the master plans proposed by Japan International Cooperation Agency (JICA) and other international donors.[16] Regionally speaking, Cambodia has the lowest share of

subnational expenditures, making it almost impossible for sub-national administrations to design and implement small infrastructure or development projects in their designated area.[17] Secondly, investments in these areas are not only to reduce traffic congestion but also to strengthen the city. Connections between people from different backgrounds and economic situations are essential and require public space and areas of social infrastructure that allow people to connect.[18] Increasingly, both the high-income and the emerging middle-income class flock to car-dependent gated communities, following very much the United States model that we argue contributes to polarization in society and sows distrust between people of different backgrounds.

We argue that real investments and prioritization in quality, fast, clean public transport can assist, but not completely fix, this growing stratification, and help provide small but essential 'bridging' social capital opportunities.[19] Bold steps are needed to guarantee investments in real public transportation solutions that are faster, cleaner, and overall, the best option, for all socioeconomic classes.

11. *Cities Aren't Loud: Cars Are Loud.* (2021). Retrieved May 20, 2022, from https://www.youtube.com/watch?v=CTV-wwszGw8.

12. The proposed skytrain project was first proposed over a decade ago but an actual construction start date has yet to be announced. Clark, James. "Phnom Penh Metro – an Ongoing History of the Proposed Urban Rail Transit System in Phnom Penh." Future Southeast Asia, July 27, 2021. https://futuresoutheastasia.com/phnom-penh-metro/.

13. Eung, Nguonsong, and Kasem Choocharukul. "Modeling Frequency of Using Informal Public Transport and Public Bus: A Case Study in Phnom Penh, Cambodia." *Engineering Journal* 22, no. 3 (2018): 109–22. https://doi.org/10.4186/ej.2018.22.3.109.

14. Grescoe, Taras. *Straphanger: Saving Our Cities and Ourselves From the Automobile.* Toronto, Ontario, Canada: HarperCollins Publishers, 2013.

15. Ibid.

16. World Bank Group. "Urban Development in Phnom Penh," 2017.

17. "Fiscal Decentralization Reform in Cambodia Progress Over the Past Decade and Opportunities," December 2018.

18. "Social infrastructure is not "social capital" — a concept commonly used to measure people's relationships and interpersonal networks — but the physical conditions that determine whether social capital develops. When social infrastructure is robust, it fosters contact, mutual support, and collaboration among friends and neighbors; when degraded, it inhibits social activity, leaving families and individuals to fend for themselves. Social infrastructure is crucially important, because local, face-to-face interactions — at the school, the playground, and the corner diner — are the building blocks of all public life. People forge bonds in places that have healthy social infrastructures — not because they set out to build community, but because when people engage in sustained, recurrent interaction, particularly while doing things they enjoy, relationships inevitably grow." Klinenberg, Eric. Palaces for the People (p. 5). Crown/Archetype. Kindle Edition.

19. Putnam, Robert D. Essay. *In Bowling Alone: The Collapse and Revival of American Community,* 22. New York, NY: Simon & Schuster Paperbacks, 2020.

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Originally from Texas (USA), he left in 2004 to begin a life abroad and explore other cultures and lifestyles. He has visited more than 20 countries and has lived and work in Japan, Korea, and Cambodia. He recently relocated to Tokyo, Japan and returns to Cambodia throughout the year. Corbett holds a B.A. in American Studies from the University of Texas at Austin, and an M.A. in International Development from American University in Washington DC.

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ACTIVE TRANSPORT FOR SMART CITIES:
Perception and Travel Behaviors of People in Phnom Penh

YAT YEN   SOKPHALKUN ROS

Introduction

The attitude and perceptions of people play an essential role in explaining individual differences in travel choices.[1] Adams et al. (2016) explained that a positive perception of workplace built environment was significantly associated with their daily commute to work in England.[2] Huang et al. (2019) added that employment densities are positively associated with more walking in the neighborhood.[3] The socioeconomic factors are also vital in determining their walking behaviors. For instance, Curl and Mason (2019) indicate that the age and gender of people also play a significant role in walking decisions.[4] Duim et al. (2017) agreed that most older people in Brazil prefer walking but cannot cross the streets at their speed. Thus, there is an urgent need to adjust the traffic environment to prevent accidents involving pedestrians, and to promote urban mobility.[5] Davey (2006) emphasizes that people with a lower proportion of car ownership are more likely to walk.[6] In contrast, a study by Timmermans et al. (2019) concerned neighborhood safety perceptions, such as physical/social disorder, crime-related safety,

and traffic-related safety. The authors found that higher safety levels were significantly associated with more cycling and walking among women and individuals of Turkish and Moroccan origin women living in the Netherlands.[7]

Although a large body of literature explains the determinants of walking behaviors, most of the literature concentrates on Western countries or America; a few studies investigate walking behaviors at the neighborhood level in developing countries by looking at different factors affecting walking intention and behaviors. The present study filled this gap by exploring the socioeconomic variations in attitudes and perceptions among Phnom Penh's residents and the impact of perceived built and social environment on walking frequency in their neighborhoods. Specifically, the study intended to measure the perception of people living in Phnom Penh on their neighborhood-built environment and modes of travel. This study answered the questions on (1) how people perceived their community built and social environment, such as the characteristics of sidewalks, intersections, perceived safety, and environment, and (2) which modes of transport they prefer when they access essential services, and (3) how the neighborhood built environment affects travel modes and travel behaviors.

Methods and Materials

The study employed a field observation and survey to capture sidewalk characteristics, neighborhoods' built-environment, intersections, perceptions, and travel behaviors. The questionnaire was adapted from Active Living Research (https://

1. Kroesen, M. and C. Chorus, *A new perspective on the role of attitudes in explaining travel behavior: A psychological network model.* Transportation Research Part A: Policy and Practice, 2020. **133**: p. 82-94.

2. Adams, E.J., F.C. Bull, and C.E. Foster, *Are perceptions of the environment in the workplace 'neighbourhood' associated with commuter walking?* Journal of Transport & Health, 2016. **3(4)**: p. 479-484.

3. Huang, R., et al., *Higher residential and employment densities are associated with more objectively measured walking in the home neighborhood.* Journal of Transport & Health, 2019. **12**: p. 142-151.

4. Curl, A. and P. Mason, *Neighbourhood perceptions and older adults' wellbeing: Does walking explain the relationship in deprived urban communities?* Transportation Research Part A: Policy and Practice, 2019. **123**: p. 119-129.

5. Duim, E., M.L. Lebrão, and J.L.F. Antunes, *Walking speed of older people and pedestrian crossing time.* Journal of Transport & Health, 2017. **5**: p. 70-76.

6. Davey, J.A., *Older people and transport: coping without a car.* Ageing and Society, 2006. **27(1)**: p. 49-65.

7. Timmermans, E.J., et al., *Associations of neighbourhood safety with leisure-time walking and cycling in population subgroups: The HELIUS study.* Spatial and Spatio-temporal Epidemiology, 2019. **31**: p. 100300.

activelivingresearch.org) and the walkability checklist (http://www.bike.cornell.edu/), and then it was contextualized to meet the local socioeconomic contexts of Phnom Penh. The study applied face to face and online survey techniques. The respondents were asked for their verbal consent before the questionnaire was handed in for face-to-face interviews. The researcher approached the respondents via Facebook and LinkedIn Messenger for the online survey and asked them two questions. (1) if they are living in Phnom Penh. If the answer was "Yes," we continued to ask for their consent to participate in our study. If the answer was "No," we thanked and left them. However, they agreed to join our survey; we instructed them and shared a fill-in link. Most items were measured using multiple choices and 5 Likert scales. The study applied descriptive and multiple analyses to generate empirical findings.

Results

Respondent Characteristics

The study collected 564 samples (Male 36.7 percent vs.63.3 percent), of which a number of samples for the online survey were 281, and face-to-face interviews were 283 (Table 3). The reliability using Cronbach Alpha was 0.866. Respondents aged between 19-29 (64.4 percent) and 30-39 (30.5 percent) were the active groups for economic contribution. It is also noted that 92.6 percent of the respondents attained higher education levels, and 59.1 percent were formally employed, either by a public or private institution. Our samples were mixed by different economic statuses, ranging from 32.4 percent, 38.8 percent, and 28.7 percent for low, middle, and high income. Furthermore, most respondents (97.5 percent) reported a healthy status, except 2.5 percent, who indicated their health was not good.

Table 1: The characteristics of the respondents

| Variable | Measure | Classified by Gender | | | | | |
| | | M | | F | | Total | |
		N	%	N	%	N	%
Age (Year old)	≤18	26	12.6	15	4.2	41	7.3
	19-29	136	65.7	186	52.1	322	57.1
	30-39	42	20.3	130	36.4	172	30.5
	40-49	3	1.4	24	6.7	27	4.8
	≥50	0	0	2	0.6	2	0.4
Education	≤High School	26	12.6	16	4.5	42	7.4
	University	181	87.4	341	95.5	522	92.6
Job	Unemployment	31	15.0	55	15.4	86	15.2
	Private employee	70	33.8	121	33.9	191	33.9
	Gov't Official	37	17.9	105	29.4	142	25.2
	Student	69	33.3	76	21.3	145	25.7
Income	Low income (≤$250)	86	41.5	97	27.2	183	32.4
	Middle income ($300-$650)	78	37.7	141	39.5	219	38.8

| Variable | Measure | Classified by Gender | | | | | |
| | | M | | F | | Total | |
		N	%	N	%	N	%
Health	High income (≥$700)	43	20.8	119	33.3	162	28.7
	Poor	6	2.9	8	2.2	14	2.5
	Normal	113	54.6	172	48.2	285	50.5
	Healthy	88	42.5	177	49.6	265	47.0

Service Accessibility

Travel Modes to Service Locations

Figure 1 explains the modes of transport the respondents chose to access service locations within the city. The motorbike and car represented the first and second preferred modes of transport the respondents used to access services. It is worth noting that walking was the third choice when they accessed a nearby location, for instance, a local market and bank/ATM. In contrast, the public bus was notably the least preferred mode of transport for the respondents.

Figure 1: The preferred modes of transport

Travel Modes to Service Location
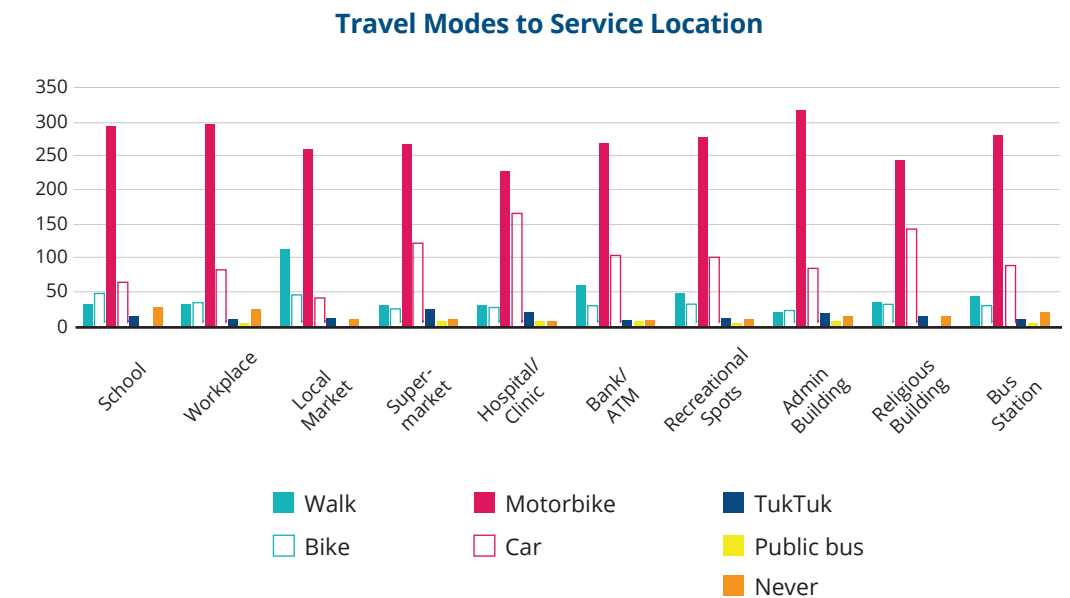
Distance to Service Locations

People prefer to live where they can access services at the shortest distance. However, Figure 2 shows that the distance from home to the basic city services, such as school, workplace, recreational spots, hospital, and administrative building, was farther than 5 km. The long distance from the service locations motivates people to choose motorized transport rather than active mode.

Figure 2: The distance to service locations

Legend: >5km | 4-5km | 2-3km | 1km | <500
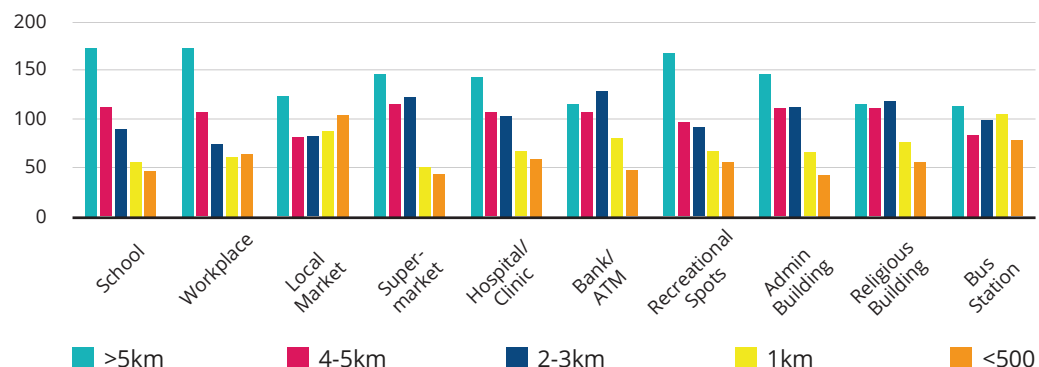
Sidewalks at Service Locations

Table 2 assesses the quality of sidewalk accessibility at the service locations. Most respondents reported that the sidewalks at the service locations are inadequate and unwalkable, especially at the local market (44.7 percent) and school (23.0 percent). In most places, only some parts of the streets were walkable. Among the ten key service locations, supermarkets have better sidewalks, where 28.7 percent of the respondents rated both sides of the streets were walkable.

Table 2: The characteristics of sidewalks at service locations

No.	Location of Services	Characteristics of Sidewalks (%)			
		1	2	3	4
1	School	23.0	48.6	6.7	21.6
2	Workplace	21.3	47.3	9.9	21.3
3	Local market	44.7	35.6	10.8	8.9
4	Supermarket	14.2	41.3	15.6	28.7
5	Hospital/clinic	21.6	46.1	15.6	16.7
6	Bank/ATM	15.1	47.7	16.0	21.3
7	Recreational spot (e.g., park)	16.3	44.0	14.2	25.5
8	Administrative building	22.5	44.3	14.9	18.3
9	Religious building	19.1	41.7	15.2	23.9
10	Bus station	20.3	40.8	16.0	23.0

Note: Rate: 4=both sides are walkable, 3= some parts are walkable, 2= Only one side is walkable, and 1=No sidewalk

Perception of Neighborhood Built-Environment

The study assessed people's perceptions of the sense of community, perceived built environment, community participation, and perceived safety (Table 3). About 48.1 percent of the respondents did not want to move out of their community because their neighborhood was very vibrant. However, at least 32.31 percent expressed a negative sense of their neighborhood. 59.2 percent of the respondents said the green space in their neighborhood was not adequate. Also, about 60.0 percent explained that it was hard for them to find a place to rest (sit) due to the lack of trees and unclean environment. Due to this, 58.46 percent of the respondents scored their neighborhood-built environment negatively. Moreover, 57.8 percent expressed a vital concern when they came at night. Overall, about 42.61 percent of the respondents negatively rated their neighborhood.

Table 3: Perception of neighborhood built environment

Variables	Response Rate					M	SD
	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)		
Sense of Community (SC)							
If I move away from my community, I will feel regret	62 (13.0)	100 (20.9)	86 (18.0)	189 (39.5)	41 (8.6)	3.1	1.2
I feel proud to live in my community	64 (13.4)	122 (25.5)	108 (22.6)	148 (31.0)	36 (7.5)	2.9	1.2
The community I live in is vibrant	44 (9.2)	93 (19.5)	117 (24.5)	179 (37.4)	45 (9.4)	3.2	1.1
I get along well with my neighbors	78 (16.3)	104 (21.4)	139 (29.1)	121 (25.3)	36 (7.5)	2.9	1.2
Group Average (%)	**10.48**	**21.83**	**23.55**	**33.30**	**8.25**		
Perceived Built Environment (PBE)							
There is enough open green space in my community	156 (32.6)	156 (32.6)	156 (32.6)	156 (32.6)	156 (32.6)	2.4	1.3
I can easily find somewhere to rest when I am tried in my community	114 (30.1)	143 (29.9)	66 (13.8)	103 (21.5)	22 (4.6)	2.4	1.2
There is enough tree shade in my community	148 (31.0)	135 (28.2)	80 (16.7)	88 (18.4)	27 (5.6)	2.4	1.3
Clean and hygiene environment	156 (32.6)	156 (32.6)	156 (32.6)	156 (32.6)	156 (32.6)	2.5	1.2
Group Average (%)	**30.33**	**28.13**	**16.43**	**20.7**	**4.38**		
Community Participation (CP)							
I care about what is going on in my community	39 (8.2)	37 (7.7)	113 (23.6)	229 (47.9)	60 (12.6)	3.5	1.1
I care about my community activities	34 (7.1)	53 (11.1)	136 (28.5)	215 (45.0)	40 (8.4)	3.4	1.0
I think my community has its own culture	87 (18.2)	127 (26.6)	174 (36.4)	72 (15.1)	18 (3.8)	2.6	1.1
Group Average (%)	**11.17**	**15.13**	**29.5**	**36.0**	**8.27**		

Variables	Response Rate						
	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	M	SD
Perceived Safety (PS)							
There is nowhere I am afraid of going in my community	71 (14.9)	109 (22.8)	105 (22.0)	154 (32.2)	39 (8.2)	3.0	1.2
I am not afraid when I come home alone at night.	113 (23.6)	168 (35.1)	77 (16.1)	100 (20.9)	20 (4.2)	2.5	1.2
No accident and robbery	140 (29.3)	157 (32.8)	97 (20.3)	70 (14.6)	14 (2.9)	2.3	1.1
Group Average (%)	**22.6**	**30.23**	**19.47**	**22.57**	**5.1**		
Overall Average (%)	**18.78**	**23.83**	**22.24**	**28.14**	**6.5**		

Note: M=Mean, SD=Standard Deviation, Rate=1=Strongly Disagree, 2=Disagree, 3=No Idea, 4=Agree, and 5=Strongly Agree

Perceived Walkability of the Neighborhood Streets

The perception of the street's walkability can influence people's walking choices. Our study assessed the characteristics of the sidewalks, drivers' behaviors, and perceived walking safety. On average, 61.04 percent of the respondents did not perceive their neighborhood sidewalks were as walkable (Table 4). In addition, 59.0 percent said that the sidewalks were not safe and convenient to walk. About 68.0 percent observed that the sidewalks were not clean due to on-street waste and dust.

Furthermore, 57.9 percent of the respondents noticed that the sidewalks were blocked or closed because of street improvement or illegally parked vehicles and business activities. The respondents also complained about heavy traffic (73.2 percent) and the lack of street trees/flowers (67.6 percent) that could motivate them to walk or bike. Despite these negative perceptions expressed by most respondents, the study found that some appreciated the quality of the sidewalks in their neighborhoods; however, these respondents mainly lived in the gated communities where the built environment was much better than in non-gated communities.

*Table 4: Perceived walkability of the neighborhood sidewalks*

No.	Perceived Walkability of Sidewalks	Rate of Perception (%)						
		1	2	3	4	5	M	SD
1	Pedestrians walk pleasantly	24.6	36.0	14.9	20.9	3.5	2.43	1.17
2	The sidewalks are convenient and safe	23.4	35.6	20.7	18.8	1.4	2.39	1.08
3	Good lighted sidewalks	17.0	23.4	14.9	40.4	4.3	2.91	1.22
4	The sidewalks are clean and smooth	26.6	42.0	17.4	11.5	2.5	2.52	1.04
5	The sidewalks are not blocked/closed	21.6	36.3	15.1	22.5	4.4	2.09	1.18
6	Less traffic	33.0	40.2	13.8	11.0	2.0	2.23	1.04
7	A lot green trees/flowers	30.5	37.1	13.8	16.0	2.7	2.47	1.13
Average		**25.24**	**35.80**	**15.80**	**20.16**	**2.97**		

Note: M=Mean, SD=Standard Deviation, Rate=1=Strongly Disagree, 2=Disagree, 3=No Idea, 4=Agree, and 5=Strongly Agree

The Attitude of Drivers

The driving behaviors on the neighborhood streets can affect the decision to travel within the neighborhood (Figure 3). About 58.4 percent of the respondents said the drivers drove very fast, while 57.7 percent noticed that the drivers turned carelessly at the road intersections. Notably, about 62.8 percent of the respondents reported that some drivers stopped/parked their vehicles on the street zebra/sidewalks, making them inconvenient to cross. Additionally, 66.8 percent of the respondents said the drivers parked their vehicles on the sidewalks and intersections. This bad parking behavior can be translated into weak legal enforcement and practices in this city. In this regard, 58.4 percent of the respondents indicated that most drivers did not obey the traffic rules.

Figure 3: The attitude of the drivers in the neighborhood

Driver Attitude (%)

Legend: Strongly disagree, Disagree, No idea, Agree, Strongly agree
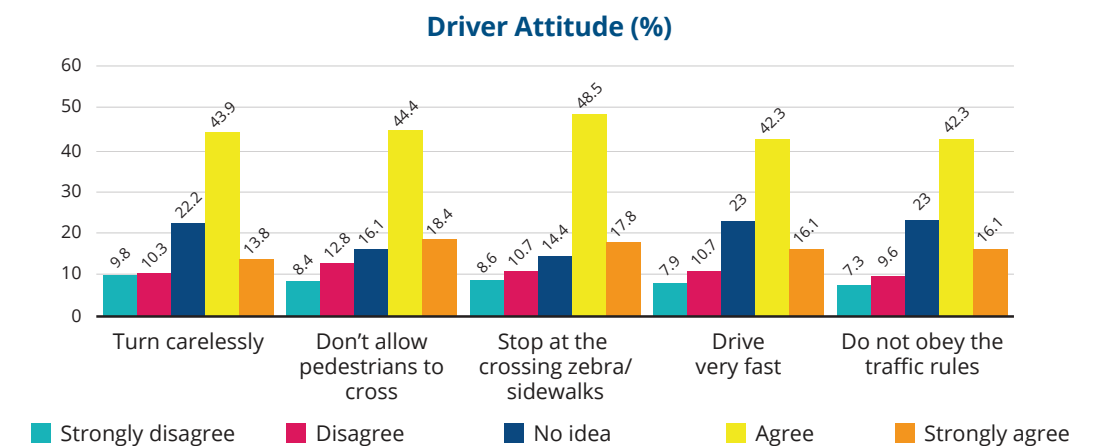
Perceived Safety for Walking

Some 70.3 percent of the respondents indicated they could not walk conveniently and safely because at least 76.3 percent and 72.0 percent worried about the possibility of accidents, or crime/strangers, respectively.

Figure 4: The perceived safety of walking

Perceived safety for walking (%)
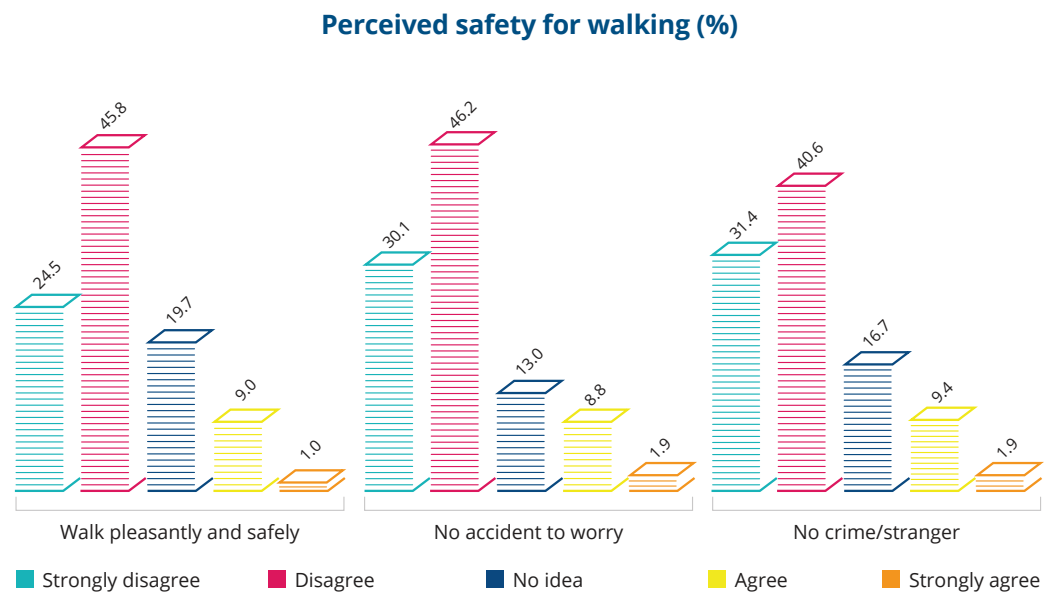
Walking Behaviors

Table 5 shows the walking behaviors of the respondents classified by their gender. The female respondents tended to walk more frequently. For example, 30.9 percent of the female respondents reported walking daily compared with 24.0 percent of their counterparts. Conversely, the percentage of the male respondents (24.0 percent) who never walked was higher than their counterparts (19.3 percent). Considering the purpose of walking, most (44.6 percent) of the respondents said that shopping (e.g., local markets) was the primary walking purpose. Doing physical exercise was the second essential purpose of walking. Comparing road selection for walking, about 60.5 percent of the respondents walked on the public road while the other 16.7 percent walked on the roads in Borey (gated community). The roads in the Borey are more convenient to walk on than the public ones because in Borey, the traffic is less heavy, and the sidewalks are clean and smooth. Because the primary purpose of walking was shopping in the local markets and thus the walking time was not long. Most respondents (55.2 percent) said they walked less than 15 minutes, while only 11.3 percent walked more than 30 minutes. About 55.7 percent of the respondents walked less than 500 m from their homes in terms of walking distance, and only 10 percent walked longer than 3 km.

Table 5: The walking behaviors in the neighborhood

| Walking Behaviors		Classified by Gender					
		M		F		Total	
		N	%	N	%	N	%
Walking behaviors	Everyday	40	24.0%	96	30.9%	136	28.5%
	2-3 days/week	48	28.7%	99	31.8%	147	30.8%
	2-3 times/month	39	23.4%	56	18.0%	95	19.9%
	Never	40	24.0%	60	19.3%	100	20.9%
Purpose of walking	To do exercise	41	24.6%	62	19.9%	103	21.5%
	To work	13	7.8%	43	13.8%	56	11.7%
	To school	13	7.8%	31	10.0%	44	9.2%
	To do shopping	78	46.7%	135	43.4%	213	44.6%
	Never	22	13.2%	40	12.9%	62	13.0%
The preferred road for walking	Public road	100	59.9%	189	60.8%	289	60.5%
	Roads in Borey	28	16.8%	52	16.7%	80	16.7%
	Others	24	14.4%	44	14.1%	68	14.2%
	Never	15	9.0%	26	8.4%	41	8.6%
Duration of walking	≤5 minutes	24	14.4%	57	18.3%	81	16.9%
	10-15 minutes	78	46.7%	105	33.8%	183	38.3%
	20-30 minutes	37	22.2%	92	29.6%	129	27.0%
	≥30 minutes	13	7.8%	41	13.2%	54	11.3%
	Never	15	9.0%	16	5.1%	31	6.5%
Distance of walking	≤100m	31	18.6%	44	14.1%	75	15.7%
	200-500m	72	43.1%	119	38.3%	191	40.0%
	1-2km	36	21.6%	95	30.5%	131	27.4%
	≥3km	14	8.4%	34	10.9%	48	10.0%
	Never	14	8.4%	19	6.1%	33	6.9%

The Preferred Mode of Daily Trips

Phnom Penh's population is young, and thus they are active travelers. Our study found that most respondents made at least three trips to different locations every day, each taking about 20 minutes. Only 25.8 percent of other respondents made their fourth trip.

The main purposes of the daily trips they made were to work (22.18 percent) and school (22.01 percent) for their first trip. The number of respondents who reported going to work and school increased from 29.92 percent to 39.75 percent and from 25.31 percent to 39.12 percent for the second and third trips, respectively. Doing business and shopping were also the primary purpose of daily trips. The shopping purpose increased from 14.85 percent on the first trip to 19.04 percent on the second trip; however, it fell to 4.18 percent and 0.63 percent for the third and fourth trips, respectively.

Figure 5: *The purposes of the daily trips*

Purposes of Trips Per Day (%)
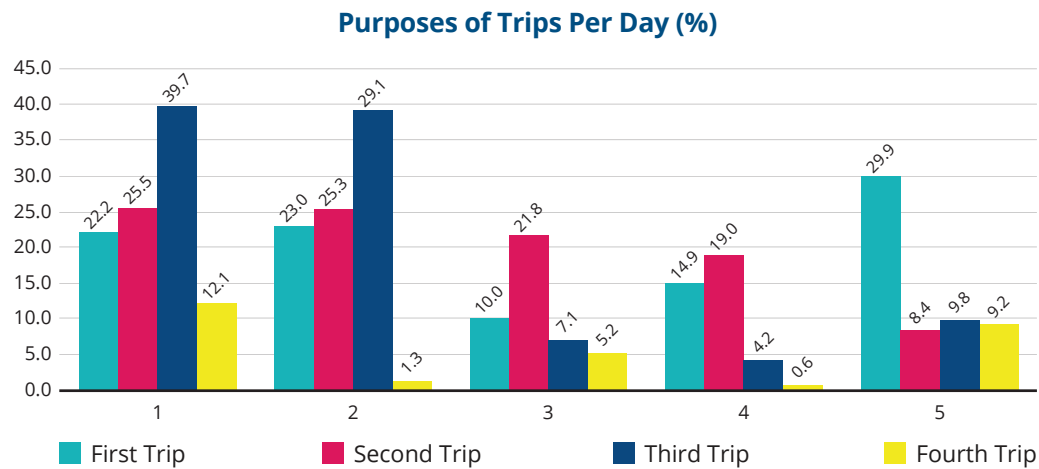
Motorbikes accounted for the highest percentage (about 73 percent) of the daily trips, except for the fourth trip, which only a small proportion of the respondents made (Table 6). Interestingly, although the percentage of the walking mode was just 7 percent, it represented the second preferred mode of transport. Three-wheeled motorbikes (Tuk Tuks) have become the third most popular model, which represented 3.9 percent of daily trips, whereas cars represented only 2 percent. The lower rate of car ownership, a short trip distance, and the flexibility and convenience of three-wheeled motorbikes could be why the share of car modes for transport is lower. Furthermore, very few percent of the respondents used buses and taxis.

**Table 6:** *The preferred modes of daily trips*

No. of Trips per Day	Preferred Modes of the Daily Trip (%)							
	Walking	Bike	Motorbike	Three-wheelers	Car	Taxi	Bus	Others
1	7.1	5.5	73.8	3.4	2.3	1.2	5.7	1.1
2	6.0	5.3	72.9	5.0	2.0	1.4	5.7	1.8
3	8.2	5.1	73.0	3.4	2.0	1.4	5.9	1.1
4*	2.8	1.6	23.6	0.2	0.9	0.5	2.3	0.0

For the fourth trip, only 24.5% of the respondents made the trip.

The Duration of the Daily Trip

The people took 19 minutes, 20 minutes, and 21 minutes for the first, second, and third trips, respectively. Frequently, on the first trip, about 37.3 percent of the respondents took less than 10 minutes, while 21.1 percent took around 30 minutes (Figure 6). The percentage (25.1 percent) of the respondents who spent about 30 minutes on the third trip increased. Remarkably, some respondents spent around one hour on their daily trips. In addition to the long-distance, the current traffic condition may cause a longer time to reach their final destination.

Figure 6: *The duration of the trip from origin to destination of each trip*

Duration of Trip from Origin to Destination (%)
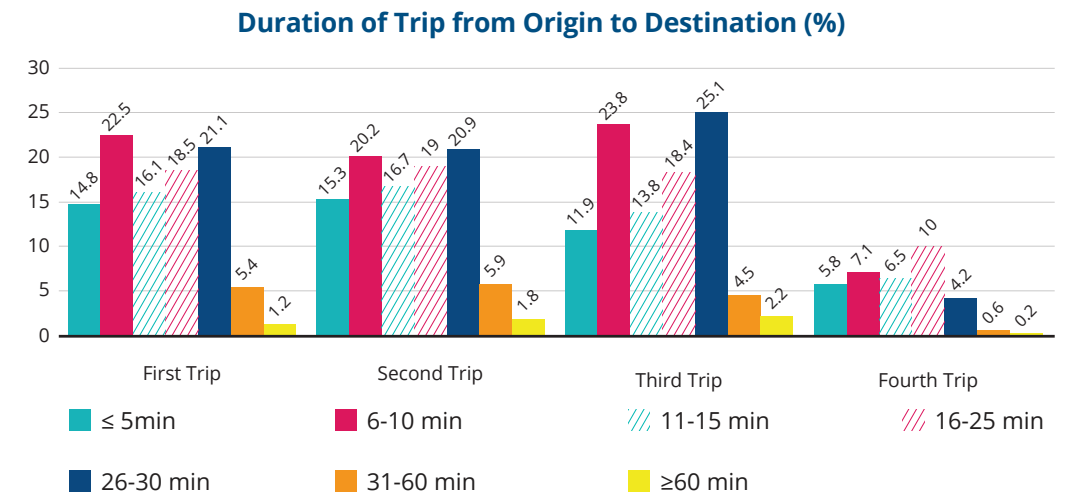
Discussion

The psychological factor plays a significant role in people's decisions on their housing location. Our study found that 38.1 percent of the respondents did not want to move away from their community. Of course, several factors motivate them not to move away, including unaffordability for a new house or the other housing locations with similar characteristics that could not make their living different. According to Li et al. (2020), residential preferences in six US cities were associated with sociodemographic status and neighborhood-built environment. The stronger preference not to move was correlated with being older, female, and having lower education. Our findings were similar to Li et al. (2020) that the sociodemographic characteristics, especially age, education, employment, and income, were significantly associated with a neighborhood-built environment. The findings suggest that neighborhood self-selection effects are most influential for more advantaged and wealthy populations. Furthermore, people generally prefer living in a place where they can access the key services at the shortest distance.[8] However, our results showed that the distance from homes to the critical services was longer than 5 km. A longer distance of the services encourages people to choose private vehicles as a means of transport, resulting in an increasing number of private vehicles. Therefore, the policy aims to promote non-motorized transport cannot be achieved if there is no action plan to transform the current street characteristics and service distributions.

Promoting urban walkability relies on physical infrastructure (i.e., built environment) and soft infrastructure (i.e., people's perception and travel behaviors).[9,10,11] When asking the

8. Giacomin, D.J. and D.M. Levinson, *Road network circuity in metropolitan areas.* Environment and Planning B: Planning and Design, 2015. **42(6):** p. 1040-1053.

9. Bornioli, A., G. Parkhurst, and P.L. Morgan, *Affective experiences of built environments and the promotion of urban walking.* Transportation Research Part A: Policy and Practice, 2019. **123:** p. 200-215.

10. Ghani, F., et al., *Do differences in built environments explain age differences in transport walking across neighbourhoods?* Journal of Transport & Health, 2018. **9:** p. 83-95.

11. Hahm, Y., H. Yoon, and Y. Choi, T*he effect of built environments on the walking and shopping behaviors of pedestrians; A study with GPS experiment in Sinchon retail district in Seoul, South Korea.* Cities, 2019. **89:** p. 1-13.

respondents to rate the overall walkability of the streets, sidewalks, and intersections, about 15 percent and 43 percent of them realized that streets, sidewalks, and intersections were hazardous and required a significant retrofit. Therefore, our study affirmed that the physical infrastructure of the sidewalk did not fully perform their roles in providing walking and biking accessibility. Moreover, our study also showed that 58.8 percent of the respondents expressed negative perceptions of the walkability on neighborhood sidewalks. Specifically, 59.2 percent of the respondents said they could not walk pleasantly due to broken and unclean sidewalks. The negative perception, such as safety, ease of access, and aesthetics (e.g., flowers and trees), affects the trip decision. These findings are consistent with previous studies, such as Lamíquiz, and López-Domínguez (2015), who found that physical accessibility strongly influenced urban walkability in Madrid, Spain. As such, our study has substantial implications for urban planners and retailers to revitalize retail zones in the neighborhood environment. Another issue of the sidewalks raised by the respondents was safety. Some 70.3 percent of the respondents expressed safety concerns when they walked on the neighborhood streets, especially at night. Statistically, 76.3 percent worried about accidents, and the other 72.0 percent worried about the crimes (e.g., robberies) when walking. This finding aligns with Mason et al. (2013), who found perceptions of several serious antisocial behaviors, such as burglary, and a sense of personal safety when walking alone in the local area at night.[12] Respondents not only rated the sidewalks negatively, they also rated the road intersections as dangerous. Our

findings revealed that 60.1 percent of the respondents criticized the poor conditions of the road intersections, where they could not walk conveniently and safely because the traffic view was blocked by illegally parked vehicles or other objects. In addition, the traffic lights and markings for the pedestrians at the intersections were not sufficiently installed. According to Cambra and Moura (2020), improving sidewalks and intersections can change the walking behaviors and improve the walking volumes.[13] Therefore, the urban planners of Phnom Penh should reconsider retrofitting the sidewalks and intersections by improving street markings and installing way findings and traffic signals. Regarding the daily trips, the majority made about three daily trips, except 24.5 percent of others who could make up to four trips. The respondents took 19 minutes, 20 minutes, and 21 minutes for the first, second, and third trips, respectively. Many studies indicate that a more extended trip duration for a given distance is associated with lower emotional well-being regardless of the mode.[14, 15] Cœugnet et al. (2013) explained that driving a motorbike or car under specific driving conditions, such as long-distance, high-frequency, under time pressure, and on congested roads, is significantly related to high levels of negative emotions such as anger, stress, fatigue, and frustration.[16] Besides, De Vos (2019) added that trips undertaken alone are correlated with lower

levels of travel satisfaction than trips made together with someone. Therefore, Ettema et al. (2012) suggested that in-vehicle activities or talking to others during the trip could improve commuters' satisfaction and emotional wellbeing.[17] However, on emotional well-being, various types of travel companionship (e.g., children, spouse/partner, co-worker, and friends) need to be investigated. Mainly, Cambodian commuters use a motorbike that is commonly carrying a single driver—as such, talking to someone during the trip in order to reduce travel stress and frustration sounds inappropriate. Hence, to improve the emotional wellbeing of trip-makers, it is better to reduce travel distance from the origin to destination as well as provide alternative modes of trips that allow them to interact with their companions or other social groups.

Conclusion

This study provides empirical evidence on the neighborhood-built environment, sociodemographic characteristics, and service accessibility of Phnom Penh, relying on people's perceptions. The respondents in this study were the active members of the urban population who demanded greater urban mobility. The results showed that some respondents did not want to move out of their living place. However, most of them were not satisfied with their neighborhood-built environment. This was most notably due to the poor conditions of sidewalks and intersections, poor aesthetics, the absence of trees and space, a perceived lack of safety, and the long-distances required to access core services. Moreover, the respondents also raised a severe concern when walking in their neighborhoods due to the inconvenience of walking and biking. Only 28.5 percent of the respondents reported

walking daily, but most (55.7 percent) walked less than 15 minutes with a distance shorter than 500m. The primary purpose of their walking was to the grocery stores or local markets. When discussing daily trips, many respondents made a maximum of three trips per day, except 25.8 percent of the total respondents made up to four trips daily. On average, it took the respondents about 20 minutes from the origin to the final destination of each trip.

The findings of this study encourage the urban planners and real estate developers to design communities (i.e., Boreys) that correspond to the needs of the people, particularly the walking facilities and safety assurance. Improvement of the neighborhood-built environment not only attracts people to live in but also promotes physical activities. The active living environment can thus enhance people's social well-being and quality of life.

Although this study provides empirical findings, the small sample size may not represent the perception of other population groups. Meanwhile, this study focused on people's psychologically inconstant viewpoints over time. Therefore, a follow-up study (longitudinal study) may provide insightful findings. The future study can include the residential preference of the lower and middle classes as one of the critical variables to explore. Over the past ten years, the huge rise rise in the number of new Boreys, and the positive perceptions people have of living in them could lead to improvements in overall urban planning - as the Phnom Penh population increasingly prioritises quality of life, the ease of access to essential services and safety assurance. It can be of interest to investigate the perceived safety and accessibility of walking among Borey and non-Borey residents using determinants of socioeconomic and built environments.

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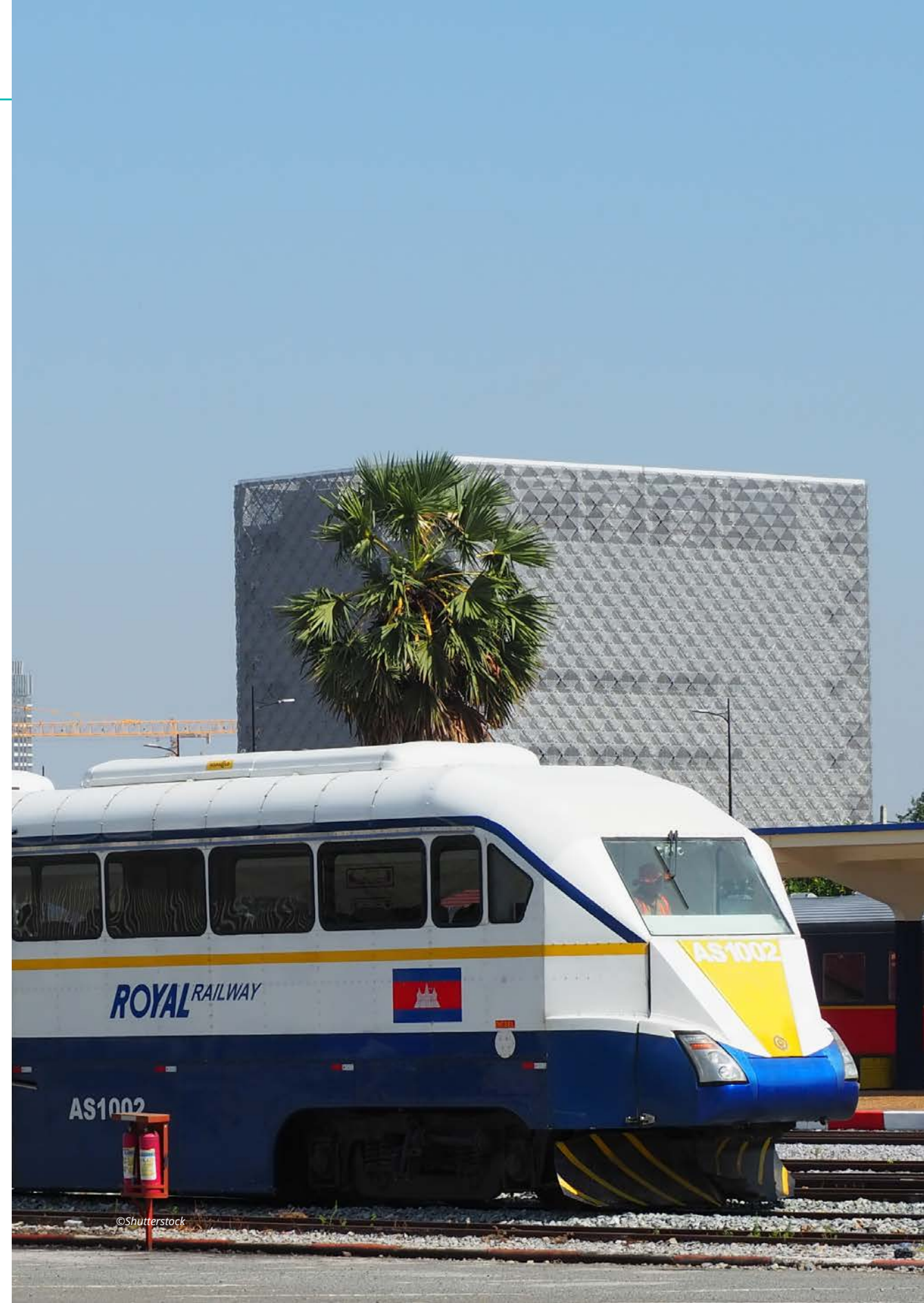
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INTELLIGENT TRANSPORTATION SYSTEMS (ITS) TO IMPROVE ROAD AND TRAFFIC LAWS IN PHNOM PENH CITY

VANNAK KHAN

Introduction

Transportation is one of the crucial sectors for social and economic development globally. It is like a blood vessel for each city to survive. Modern transportation systems need to be developed to make the city innovative, livable, and sustainable. Cambodia needs her capital city to be ready and suitable for the next generation. However, traffic congestion is one of the biggest challenges in Phnom Penh. There are four main reasons behind traffic congestion concerning the increasing number of vehicles, quality of infrastructure, public disobedience of road rules and traffic law, and poor enforcement of traffic laws by police and authorities.[1] Among those mentioned above, this research will focus on the last two reasons because they can be solved by using Intelligent Transportation Systems (ITS). This study aims to find out how ITS technology can improve traffic and road laws. The paper will review some suitable lessons learnt concerning ITS deployment in many countries to achieve this. At the same time, some existing ITS projects are also reviewed to find out how it is implemented in Phnom Penh city. The structure of this study is divided into three main parts. In the first part, the definition of ITS is defined. In the second section, the paper reviews how ITS can improve traffic law, and safety, provide traffic information, prevent road hazards, and help authorities to reinforce traffic violations. Lastly, the paper will explain how the system can improve urban mobility by increasing the speed of public buses and private vehicles.

ITS Definition

Many developed and developing countries have developed Intelligent Transportation Systems (ITS) in their cities. The deployment varies from one region to the other. It usually depends on the level of development, research, and technology capacity. An intelligent Transportation System (ITS) is defined as a technology that can modernize vehicles to manage vehicle traffic, assist drivers with safety and other information, and provide convenient applications for passengers and road safety.[2] Johann and Steve defined ITS as a transport solution that uses information and communication technology (ICT). ITS is a combined system of people, roads, and vehicles, designed to significantly improve road safety, efficiency, comfort, and environmental conservation through the realization of smoother traffic by relieving traffic congestion.[3] There are definitions from some countries related to ITS around the world.

Table 1: *Intelligent Transportation Systems (ITS) definition*

Organization	Definition
European Union	Applications of information and communication technology to transport
ITS United Kingdom	An integration of ICT that allows delivery of online information to both public and private management from all areas

1. Sahmakum Teang Tnaut, "Traffic in Cambodia. A Report on Traffic Issues in Phnom Penh from 2014 to 2017." 2017, F&F 34: Phnom Penh.

2. Anand Paul, Naveen Chilamkurti, Alfred Daniel, and Seungmin Rho, Intelligent Vehicular Networks and Communications: Intelligent transportation systems. Elsevier, 2017, 21-41. https://doi.org/10.1016/B978-0-12-809266-8.00002-8

3. Johann Andersen and Steve Sutcliffe, "Intelligent Transport Systems (ITS) - An Overview," 2000, ScienceDirect, v 33, 99-106. https://doi.org/10.1016/S1474-6670(17)37129-X

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Organization	Definition
ITS Japan	A system that exploits information technology to assist the comfortable and efficient transportation for people and goods. It provides safety, efficiency, and comfort in transport services.
ITS Canada	Advanced applications that use computers, sensors, controls, and electronic devices in transportation systems to save lives, time, money, energy, and the environment.
Republic of Korea	Transportation systems can improve efficiency and safety by using automated systems management. A system provides transportation data through services that integrate technologies and communication among vehicles and other facilities.
China	ITS is a new invention of transportation systems that can improve safety, efficiency, accessibility, and advanced technology applications.

Source: Intelligent Transport Systems for Sustainable Development in Asia and the Pacific, 2017, UNESCAP.

ITS aims to provide drivers and riders with a better service in the transport system.[4] Most

developing countries get more benefits from Traveler Information, Demand Management, Electronic Financial Transactions, and Public Transport Management. Low and middle-income countries can adopt the ITS technologies to improve traffic management, traffic congestion, and public transport management.[5] To get benefits from ITS, Cambodia should adopt some systems related to advanced traffic management services, advanced traveler information services, advanced vehicle services, and advanced public transport management.

ITS Improves Road Safety and Provides Real-Time Information to Travelers

Recently, ITS has helped to improve road safety. Globally, around 1.3 million citizens die on the roads every year, and approximately 20 to 50 million are injured or get disability due to the injury.[6] Traffic accidents kill 5 Cambodian people every day,[7] and cause the government to lose around USD 350 million every year.[8] The death and trauma rates can be reduced if there is a quicker reaction from the emergency medical system. Jobann and Steve mentioned that ITS could reduce traffic accidents by 29 percent to 40 percent, improve speed by 13 percent to 48 percent, and congestion on

expressways by 70 percent.[9] ITS can reduce traffic accidents and improve congestion by changing the drivers' behavior. Using ITS can bring safety for mobility up to 75 percent of accidents.[10] In a report, the Seoul Metropolitan Government stated that Bus Management System/Bus Information Systems could reduce 49 percent of traffic accidents.[11] In China, by using the Automatic Emergency Braking (AEB) system, the government can avoid 2483 fatalities and 3940 injuries.[12]

Intelligent transport systems affect the mind of the driver while driving. Awareness that is assisted by systems plays a significant part in an advance notice about current traffic circumstances and arranging the vehicle before it begins. Drivers can check street traffic circumstances with real-time information.[13] ITS plays a critical role in providing travelers traffic information on what they should do when commuting. The cooperative hazard warning systems can inform drivers of approaching dangerous objects, traffic problems, and unsafe road conditions. It can enable the driver to assess

the real-time road conditions nearby, and help them to avoid incidents. It can help to reduce road fatalities from 1 percent to 5 percent.[14]

Another area of ITS is the early warning system, the system alerts drivers to know what is happening on the roads that they are driving. Users can get redirection from the system to avoid congestion.[15] In Sweden, ITS can assist drivers to know about dangerous situations such as collisions, crashes, and the costs.[16] Drivers can assess the real time road information provided by the system, and use that information to avoid the incident.

Automatic crash notification—The system installed inside a vehicle can naturally make a phone call to inform administrations when a crash happens. Using this application, street fatalities have decreased by around 5 percent.[17] Like the crash notification system, the eCall system was also attached to the vehicle and automatically called the health emergency team to intervene in the accident. It can save people from road fatality by around 3.6 percent.[18]

4. J. Zhang, F.-Y. Wang, K. Wang, W.-H. Lin, X. Xu, and C. Chen, "Data-driven intelligent transportation systems: A survey,"2011, IEEE Transportation Intelligent Transport Systems, v 12, 1624–1639. http://dx.doi.org/10.1109/TITS.2011.2158001

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12. Hong Tan, Fuquan Zhao, Han Hao, Zongwei Liu, Amer Ahmad Amer, and Hassan Babiker, "Automatic Emergency Braking (AEB) System Impact on Fatality and Injury Reduction in China," 2020, International journal of environmental research and public health, 17(3), 917. https://doi.org/10.3390/ijerph17030917

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18. Niina Sihvola, Juha Luoma, Anna Schirokoff, Jari Salo &Kari Karkola, "In-depth evaluation of the effects of an automatic emergency call system on road fatalities." 2009, European Conference of Transport Research Institutes (ECTRI), 99-105. http://dx.doi.org/10.1007/s12544-009-0016-3.

ITS Helps the Authorities Reinforces Road Rules and Traffic Laws

With the innovation of ITS technology, many nations use it to improve their capacity for traffic law enforcement. In South Africa, the government uses ITS with artificial intelligence and intelligent surveillance in their city. The installed smart traffic signals at the intersection can reduce traffic congestion.[19] Radio Frequency Identification (RFID) and CCTV camera systems are essential for authorities to enforce traffic law.[20] These tools are used in the intelligent transportation system to record and send the data from the road to the traffic management hub / traffic information center. ITS can also be used for automated toll collection, enabling authorities to collect fees without the need for vehicles to stop. The system detects the signal and automatically gets a fare from the bank.[21] This system is the best solution for solving traffic congestion.[22] In South Korea, the Automatic Traffic Enforcement System (ATES) is the system that collects data from the CCTV and sensors on the road to track and record unlawful vehicles before sending the information to the Traffic Information Center. The system classifies the data into four parts: reserved lanes regulation data, signal violation regulation data, speed violation regulation data, and illegal parking regulation data. Then, this data will be sent to the police station, and the bill will be sent back to the driver.[23]

ITS can help police to reinforce the traffic law and road safety. Currently, manual speed guns are used by police officers in specific locations. This manual work is not good enough to control many vehicles simultaneously within 24 hours. In Korea, the implementation of the Automated Speed Enforcement (ASE) System reduces the mean and variance of car speed. 70 percent of drivers reduce their speed by at least 5 km/h and decrease road fatalities by about 40 percent to 80 percent within 2 km of where the cameras were installed.[24] The system also provides concrete evidence to the police to decrease drivers' complaints. A 10 years-study in Germany shows that police use of automatic radar devices to limit speed, and strict surveillance in dangerous road sections provides positive results for road traffic and law enforcement.[25] In Great Britain, a 24 year study of speed camera installation on roads revealed that the system could save 190 lives and social costs of around GBP 27 million annually.[26]

The Weigh-in-Motion control system is the tool to reinforce quantity violators and overweight vehicles. Such a system was reduced in Russia, which reduced the number of non-compliant (over-weight) vehicles by over 99%.[27] In Phnom Penh and across Cambodia, the MPWT now plans to deploy a similar system.[28] The system uses sensors and CCTV cameras that were installed on the national roads to record vehicle information such as type, identity, number, and weight. It also records the vehicles that weigh and do not weigh. The system will report to authorities about the overweight trucks.

Smart Traffic Systems. Such as system was recently installed on national road number 3 to provide concrete evidence for police to reinforce traffic compliance. All necessary information is recorded by the system, including seat belt usage, vehicle speed, registration number, and vehicle type. This system provides crucial evidence for authorities to punish unlawful drivers.[29]

RoadCare Application is another of the practical applications created and applied by the MPWT to repair roads nationwide. It was able to solve 24 percent of the problems reported through its system. Furthermore, the system added more functions to report road violations and traffic accidents. This system can help all relevant authorities respond on time when incidents happen on Cambodia's roads.[30] MPWT developed a scanning technology to detect drivers for violating a traffic law. Police use the system to capture images of cars that violate traffic laws. When the police scan the driving license of the drivers, the score will be deducted from their driving license. The number of scores will be cut from the license depending on the level of violation.[31]

ITS Improves Urban Traffic and Mobility

ITS can monitor the traffic flow and improve mobility in the city by assisting the traffic flow, increasing the speed of vehicles, and smart parking. The system can help alleviate environmental pollution and reduce traffic problems by improving traffic flow, adapting to understand a dynamic flow, and improving traffic regulation.[32] ITSKOREA claimed that applying ITS in Korea reduces 20 percent of traffic congestion with an equal 1 percent of road construction costs.[33] In the same report, UNESCAP also claimed that applying ITS can improve average speed by around 15 to 20 percent.[34]

Public Bus Transportation is essential to improve mobility in the urban space. One of the benefits of ITS is improving speed. The average travel speed rises by 20 percent and decreases traffic congestion by 30

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25. Lamm R, Kloeckner JH, "Increase of traffic safety by surveillance of speed limits with automatic radar devices on a dangerous section of a German autobahn: a long-term investigation," 1984, Safety lit,974: 8-16. https://www.safetylit.org/citations/index.php?fuseaction=citations.viewdetails&citationIds[]=citjournalarticle_688298_38

26. Cheng Keat Tang, "Do Speed Cameras Save Lives?," 2017, Spatial Economics Research Center, London School of Economics. http://www.spatialeconomics.ac.uk/textonly/SERC/publications/download/sercdp0221.pdf

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31. Long Kimmarita, "Scanning tech said to deter drivers," 2021, Phnom Penh Post. https://www.phnompenhpost.com/national/scanning-tech-said-deter-drivers.

32. Gregorio Díaz, Hermenegilda Macià, Valentín Valero, Juan Boubeta-Puig & Fernando Cuartero, "An Intelligent Transportation System to control air pollution and road traffic in cities integrating CEP and Colored Petri Nets." 2018, Springer, 405-426. https://link.springer.com/article/10.1007/s00521-018-3850-1#citeas.

33. ITSKOREA, "Intelligent Transport Systems made in KOREA English Version 16," 2016, video, 7:24, https://www.youtube.com/watch?v=dS4pWnNlxfA

34. United Nations Economic and Social Commission for Asia and the Pacific, "Intelligent Transport Systems for Sustainable Development in Asia and the Pacific," 2017, 13. https://www.unescap.org/sites/default/files/ITS.pdf

percent.[35] According to a report from the Seoul Metropolitan Government, a reform using ITS technology helped enhance bus management efficiency, reduce traffic accidents by 49 percent, and increased citizens overall satisfaction of the bus services by 35 percent. In the USA, applying ITS in the public bus services reduced bus travel time by between 7 and 22 percent, and reduced bus delay time by between 22.5 and 33 percent.[36] We also see the improvement of public transportation after using ITS in the bus service.

According to Hyungun and Ju, the average speed of major roads in Seoul city is less than 20 km/h, but after applying ITS, the speed of vehicles increases.[37] The Seoul Metropolitan Government also stated in a report that BMS/BIS systems led to a 32% increase in customer satisfaction scores when using the bus service.[38]

Table 2. Improving Buses and Vehicles Speed in Seoul (2003-2010)

Apply ITS systems	Mode of Transportation	Improvements
	Bus operation speed (km/h)	17.2 (2003) → 19.5 (2011)
	Vehicles (km/h)	22.4 (2003) → 24.0 (2010)

Sources: SMG (2014) and Hyungun and Ju (2011)

35. Anand Paul, Naveen Chilamkurti, Alfred Daniel, and Seungmin Rho, Intelligent Vehicular Networks and Communications: Intelligent transportation systems. Elsevier, 2017, 21-41. https://doi.org/10.1016/B978-0-12-809266-8.00002-8

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37. Hyungun Sung and Ju-Taek Oh, "Transit-oriented development in a high-density city: Identifying its association with transit ridership in Seoul, Korea," 2011, Science Direct, v 28, 70-82, https://doi.org/10.1016/j.cities.2010.09.004

38. Seoul Metropolitan Government, "Seoul Public Transportation," 2014, Seoul, SMG.

In 2002, the average speed of public buses was 18.9 km/h.[39] After the bus reform, ITS enhanced the bus speed from 17.2 km/h in 2003 to 19.5 km/h in 2011, and passenger satisfaction was 59.2 percent in 2006 and increased to 74.3 percent in 2010.[40] The report also mentioned the typical travel speed in Seoul improved from 22.4 km/h in 2003 to 24.0 km/h in 2010. At the same time, the average speed of downtown rose from 15.5 km/h to 16.6 km/h. Environmentally, the fine dust improved from 70 ug/m³ in 2003 to 41ug/m³ in 2012. Intelligent Transportation Systems contribute to the improvement of the speed buses in Seoul.

Integration of ITS in Urban Mobility in Phnom Penh

Traffic management is a difficult job that every city faces every day. The traffic control center is one of the most critical actors in coordinating systems to get all traffic systems to run smoothly. Cambodia needs to upgrade its traffic control center to get better traffic supervision. In Phnom Penh, reinforcement and upgrade of the traffic signal system are required to improve traffic conditions.[41] The traffic center is one of the essential components of ITS systems in traffic management in the city.

Most traffic facilities are old and installed without proper inspection and maintenance. But there is some improvement in this sector. As such, introducing a signal control system is expected to improve the city's traffic condition. JICA report suggests that the government should improve the function of

39. Samuel Kling, "Dispatch from Seoul: City of Transportation Extremes," February 13, 2020, The Chicago Council on Global Affairs. https://www.thechicagocouncil.org/commentary-and-analysis/blogs/dispatch-seoul-city-transportation-extremes

40. Chang Yi, Chaewon Lee, and Yoon-Joo Jung, "Developing Transport Infrastructure in Seoul," 2017, Seoul, Seoul Institute.

41. Seiya Matsuoka, "Traffic management project in Phnom Penh," 2018, v 42, 180-189. https://doi.org/10.1016/j.iatssr.2018.12.001

the traffic control center.[42] In 2014, Phnom Penh municipality installed 69 signalized intersections in the city. 31 new crossings in the city center and downtown needed new traffic signal installation. These signals connect to the Area Traffic Control System[43] but it does not function well due to poor maintenance.

There is currently a traffic control center located in the Phnom Penh municipality with the support of the JICA project. This center is in operation. In the whole of Phnom Penh city, there are 109 traffic signals, 196 video vehicle detectors, and 26 traffic surveillance video cameras.[44] This equipment can record and send the traffic information to the Traffic Control Center in Phnom Penh municipality. So, the authority can monitor and take action to make traffic flow accordingly.

Table 3. Decreasing Driving Speed in Phnom Penh (km/h)

Mode of Transport	Mobility	Year
Vehicles	22.1 km/h	2000 - 2012
	15km/h	2001 - 2012

Source: JICA report 2015

The average travel speed was 22.1 km/h to 15km/h between 2001 and 2012.[45] Unfortunately, the speed will decrease during the rush hours, and travel volume gets more than 50 percent on roads. Learning from Seoul city, we should adopt ITS in our public

42. Japanese International Cooperation Agency (JICA), "Data Collection Survey for Intelligent Transport System (Phase II)," 2015, 1-119.

43. Japan International Cooperation Agency, "The Project for Comprehensive Urban Planning in Phnom Penh Capital City,"2014, Ministry of Public Works and Transport, 57.

44. Ibid

45. Japan International Cooperation Agency, "The Preparatory Survey for Project of Development of Traffic Management System in Phnom Penh," 2015,1. https://openjicareport.jica.go.jp/pdf/12184941.pdf

transport. So, the vehicle speed can be improved, as mentioned above.

Phnom Penh Autonomous Bus Transportation Authority, supported by JICA, launched the application that uses GPS to track the location of the buses. The application allows users to know the real-time location of the buses. The authority also cooperates with Wing and ACLEDA banks to help passengers pay fares by card.[46] In the last few years, there has been an increasing number of hail-riding applications such as Passapp, Grab, etc.[47] These platforms provide online transport services for passengers. It is an easy, convenient and reasonable price. This trend shows the popularity of technology in transportation mode that contributes to smart cities in the future.

With the advancement of technology, parking lots are also using ITS systems to improve their performance by helping to improve traffic management and vehicle owners to park correctly. It has been considered and applied in many countries. In Seoul, the Parking Information System (PIS) allows drivers to know the real-time available space for parking nearby them.[48] Also, drivers can use applications on their smartphones or vehicle screen to search for the parking lot where they can park. Parking users can book parking spots and pay fares online. There are some modern parking lots built in Phnom Penh city. However, no integrated systems (ITS) connect those parking spaces yet. Transport planners should mainstream this system into the parking lot.

46. Sen David, "City Hall launches bus app," July 8, 2019, Khmer Times. https://www.khmertimeskh.com/50621812/city-hall-launches-bus-app-2/

47. Shaun Turton and Bopha Phorn, "Grab takes on Cambodia's PassApp for ride-hailing supremacy," July 8, 2019, Nikkei Asia. https://asia.nikkei.com/Business/Startups/Grab-takes-on-Cambodia-s-PassApp-for-ride-hailing-supremacy

48. ITSKOREA, "Intelligent Transportation Systems made in Korea English Version 16". Accessed on April 5, 2022, from https://youtu.be/dS4pWnNIxfA.

Conclusion

Intelligent transport systems (ITS) are the best innovative technology for solving transportation challenges such as traffic congestion in the city and the world. ITS should be mainstreamed in transport planning for Cambodia. The system can help authorities improve traffic laws, reinforce road laws, and provide vital information for travelers to know about road situations when traveling. ITS gathers all data that has been happening on the roads and informs travelers to see the situation on the streets, prepare themselves for safety, and save time. Moreover, ITS is a game-changer for traffic law reinforcement. With ITS assistance, we can save many lives from road accidents. This system helps relevant authorities have clear evidence to punish the drivers who violate the traffic law. Police can also intervene on time when an incident or problem happens on the roads. This technology reminds drivers to obey the traffic law in every circumstance because ITS records their activities on the roads. In addition, ITS improves urban mobility and provides travel mode choices. Deployment of ITS in public transport can enhance the speed of vehicles and the satisfaction of transport users. After adopting ITS, public buses and private transport services increase their speed and performance. As such, Intelligent Transport Systems are the best tool to improve traffic law at low cost and effectiveness. By mainstreaming this technology, Phnom Penh can prepare itself to be a truly smart city for the future.

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DATA AND
DATA SECURITY

DIGITAL INSIGHTS: FUTURE OF CITIES

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THE IMPORTANCE OF DATA FOR THE DEVELOPMENT OF SMART CITIES IN CAMBODIA

VATANA CHEA

In recent decades, the unprecedented movement of people from rural regions to cities has been a demographic phenomenon in most developing countries. Globally, the number of people living in urban cities exceeds rural areas. Before the COVID-19 pandemic struck in early 2020, the United Nations had documented that about 56 percent of the world population is now living in metropolises, while it is predicted that this figure will increase to roughly 70 percent by 2050.[1] While it is true that big cities offer the cost-reducing advantages deriving from agglomeration economies and economies of scale and of scope, the social cost of increasingly overloaded housing and social services, crime, and pollution can potentially outweigh these urban advantages. To put it into perspective, cities around the globe are currently consuming about 75 percent of world energy and resources and producing at the same time about 80 percent of the greenhouse gas effect.[2] And these figures are expected to rise commensurately with urban growth. Moreover, such a rapid increase in urbanization might expand slums and shanty towns, causing massive public health concerns.

But such concerns have led many countries to opt for the building of smart cities, which accelerates the adoption rate. In Cambodia, the endorsement of the smart city's framework starting in Phnom Penh has also been done in the government's Digital Economy and Societal Framework 2021 – 2035, marking the next milestone of the country's development agenda. The smart city concept requires multiple state-of-the-art technologies to enhance a city's operational efficiency or delivery of public services such as education, health, transportation, energy, water supply, safety, and connectivity, leading to a higher comfort level for its residents. It also leads to a reduction in costs and time in addition to the consumption of natural resources and energy. Of all the recently developed technologies which present huge potential, data, including both survey data as well as big data (and its modeling techniques), is one of the most significant components and can be used in various beneficial ways to make the idea of smart cities a reality rather than just a vision. Data is generated exponentially as we speak. And because digital transformation has become an integral part of social and economic development, effective use of data and analytics is a key to improving security and safety, utility provision, and urban transportation systems.

Using desk review and theoretical reasoning, this essay critically investigates and elaborates on the nature of data and its application to support smart city development. In addition, I also discuss the opportunities to be capitalized on, challenges to be addressed, and benefits of incorporating big data applications and identify the requirements to facilitate the implementation of big data in Cambodia to achieve better utilization of such technology. With that said, I will begin the discourse on the concept of data to provide a foundation for further discussion.

What Is (Big) Data?

Data here mainly refers to the data generated by internet users (their profile, online purchasing habits, search pattern (on Google), and their financial transactions) and digital technologies, including mobile

1. United Nations, Department of Economic and Social Affairs Population Division, "World Urbanization Prospects: The 2018 Revision" (Washington D.C, 2018).

2. Alberto Vaquero-García, José Álvarez-García, and Marta Peris-Ortiz, "Urban Models of Sustainable Development from the Economic Perspective: Smart Cities," in Sustainable Smart Cities: Creating Spaces for Technological, Social and Business Development, ed. Marta Peris-Ortiz, Dag R. Bennett, and Diana Pérez-Bustamante Yábar (Switzerland: Springer, 2017).

phones, satellites, or IoT (Internet of Things) devices like sensors. But data also comprises other types of information such as surveys collected by asking structured questions, and qualitative data, which is gathered by interviewing people to know about their perspectives, opinions, or beliefs towards certain things. The size of the data, particularly the Big Data, is enormous and is beyond the capacity of any typical database and software to store and analyze.[3] As a result, big data requires data science, AI methods, modeling techniques, or proper analytics to efficiently organize and investigate to make a good sense of it.

It should be highlighted that big data is not an entirely new concept. It gained popularity following the boom of social media, including Facebook, Twitter, and YouTube, at the beginning of this new millennium. It provides an online platform for people to interact and share their ideas or opinions and even buy goods and services. Furthermore, it is through such interactions that data is generated automatically, and that data experts can understand the users better using their comments/posts and browsing or searching history. For example, if you are a female at childbearing age and married to someone, and you start to search for Facebook's pages selling goods and services related to infants consistently, it can be predicted that you are probably pregnant. In this sense, big data is often considered a byproduct of the digital behavior of humans or machines or a combination of the two. At the same time, machine-generated data (which mainly comes from IoT) is real-time and constitutes the most significant proportion of big data. Nevertheless, the byproducts offer much valuable information and beautiful insight about people or

countries so much as it can improve socio-economic development.[4] They are also regarded as a black swan or the new oil, which can influence or change the course of negotiation, diplomacy, and international politics.[5]

Big data has three essential characteristics: high volume, velocity, and variety. Simply put, an enormous amount of many different formats of data, both structured, semi-structured, and unstructured, is generated every day at an extremely high speed. In 2018, Forbes Magazine published an article stating that the human race globally produces about 2.5 quintillion bytes of data each day,[6] and that 90 percent of all existing data was generated only in the past two years.[7] From now on, the volume of data is also predicted to double every two years, making the data itself even more valuable due to what economists call the economies of scale and of scope and the non-rivalrous nature of data.[8] That is to say, a more significant amount of data not only offers better accuracy but combining different types of the related dataset can provide more insight than a dataset alone. In addition, once data is originated, it can be used and reused multiple times by many different people or organizations with almost zero additional cost. It is why major corporations, including Google and Facebook, have been collecting data on their users to meet their needs, satisfy them, and enrich their experience. In addition, they also sell the user's data

to other companies, which then employ it to understand their market structure and consumer behavior.[9] Therefore, data is also a crucial factor for the future success of many businesses which make data-driven decisions.

Even though economists have not been able to quantify the concept of data and its importance fully and study them in detail as they did for information, the economics of data is a growing field for research with a basic theoretical framework discussed in Jones and Tonetti. However, their model is still incomprehensive and underdeveloped.[10] Moreover, it is worth noting that the economics of data is not the same as the economics of information or idea,[11] even though they both share many similarities, optimistic economists believe that the former has a much more enormous potential in terms of increasing output than the latter, especially in the countries where the use of data is not very strict.[12] In addition, it is understood that data will be able to help solve many problems of market failure resulting from information asymmetry. For instance, financial intermediaries increasingly rely on data deriving from digital transactions to estimate potential borrowers' creditworthiness. That will assist them in addressing perpetual challenges in the financial sector in which the banks lack creditor data to do credit scoring and

hence are reluctant to lend them money.[13] As a result, data can aid in coordinating the financial market to reach a better equilibrium. In this regard, data can also be seen as Adam Smith's new invisible hand.

Big Data Application in Smart Cities

In addition to what is mentioned, data has shown significant promise in serving many sectors in a smart city. For example, it can be used to manage public transportation and traffic, optimize the use of resources, improve public safety, and enhance government services such as public education and healthcare.[14] In fact, data could be a very crucial element in realizing the goals of making Phnom Penh a smart city starting by improving public transportation and traffic systems. As we write, traffic congestion is a major problem in the capital, and it is likely to cost Cambodia, as a whole, millions of dollars every year. Why? Because (1) people waste much time getting stuck in traffic instead of doing something more productive, (2) car and motorbike drivers still need to spend money on gasoline which is burnt fruitlessly as all vehicles are jammed, and (3) burning fuel energy can cause air pollution that affects public health and generate negative externalities. Unfortunately, these three components are very difficult, if not impossible, to measure in terms of dollar loss.

But with data (and some analytics), the government can manage transportation better by understanding the patterns that lead to traffic jams, including the behavior of road users and efficiency of traffic lights,

3. S Sagiroglu and D Sinanc, "Big Data: A Review," in *2013 International Conference on Collaboration Technologies and Systems (CTS),* 2013, 42–47, doi:10.1109/CTS.2013.6567202.

4. World Bank, *Data for Better Lives* (Washington D.C: The World Bank, 2021).

5. Vatana Chea and Sopheap Ing, "International Politics of Data: Do We Need New Diplomatic Approaches for the Emergence of the New Oil?" *AVI Perspective* 2021, no. 12 (2021).

6. https://www.forbes.com/sites/bernardmarr/2018/05/21/how-much-data-do-we-create-every-day-the-mind-blowing-stats-everyone-should-read/?sh=3d24fa560ba9 (last visit May 16, 2022)

7. Sagiroglu and Sinanc, "Big Data: A Review."

8. World Bank, *Data for Better Lives.*

9. J Isaak and M J Hanna, "User Data Privacy: Facebook, Cambridge Analytica, and Privacy Protection," *Computer* 51, no. 8 (2018): 56–59, doi:10.1109/MC.2018.3191268.

10. Charles I Jones and Christopher Tonetti, "Nonrivalry and the Economics of Data," *American Economic Review* 110, no. 9 (2020): 2819–58, doi:10.1257/aer.20191330.

11. George J Stigler, "The Economics of Information," *Journal of Political Economy* 69, no. 3 (May 16, 1961): 213–25, http://www.jstor.org/stable/1829263; Paul R Romer, "Human Capital and Growth: Theory and Evidence," *Carnegie-Rochester Conference Series on Public Policy* 32 (1990): 251–86, DOI:https://doi.org/10.1016/0167-2231(90)90028-J.

12. Jones and Tonetti, "Nonrivalry and the Economics of Data."

13. World Bank, *Data for Better Lives.*

14. Eiman Al Nuaimi et al., "Applications of Big Data to Smart Cities," *Journal of Internet Services and Applications* 6, no. 1 (2015): 25, doi:10.1186/s13174-015-0041-5.

and whether or not a crossroad should have smart traffic lights in the first place. An application of data in building a smart city can be found in Shenzhen, China, in which information about the road traffic and users is collected through a mobile application on the drivers' smartphones. The drivers are, in turn, constantly informed via the same smartphone about the road situation ahead to their destination and how congested it is and are suggested an alternative route if it is predicted that the traffic jam will be severe. Furthermore, data can also be utilized to increase road safety and reduce traffic collisions through crowd management mechanisms and to identify which areas are prone to accidents and at what time so that police and ambulances can be deployed in advance to provide emergency responses. In a similar manner, data collected from transport systems can help optimize freight and shipping movement.[15]

Another essential role of data in smart city development is perhaps the enhancement of a smart grid, a renovated electrical grid system that relies on Information Communication and Technology (ICT) devices to collect data, including household's power utilization habits, and then automatically act on available information.[16] Such actions would improve the efficiency of energy consumption and the distribution of electrical power, all of which could help avoid power outages due to the overuse of electricity. It is particularly effective in the case of Phnom Penh, as the city's energy consumption has

increased rapidly over the last decade,[17] and the use of such energy is higher in April and May when Cambodia experiences extreme weather. But without big data, it is difficult for the authorities to know exactly the current user's demand, let alone predict the future need for electrical energy that will be used to power the smart city. Note that data-driven energy consumption behavior management would also benefit households since they are likely to spend less on their monthly utility bills.

Besides that, big data will solve many educational and health challenges in smart cities and beyond. With a large amount of student data, we can continuously monitor their health status, which in turn affects their educational outcomes, and their living standards as adults.[18] Using data, we can also perceive students' learning behavior and help educators design a flexible curriculum tailored to their desires, hence supporting lifelong learning and the concept of a knowledge-based society.[19] Besides, data on facial expression can be employed to recognize if a student is having problems understanding the lessons and create an interactive learning environment in the classroom customized to specific needs.[20] In some fields of study, big data can directly help with the research process. For example, astronomers can now analyze a massive astronomy dataset, including images taken from space, using a powerful computer, which has facilitated much of their work

and optimized their research output.[21] Moreover, data allows healthcare providers and practitioners to better understand their patients' health situations and issues. It is said that with big data, AI can now diagnose cancers or other diseases more accurately than a doctor can.

Potential Challenge

After all the advantages of data that I have mentioned above, it is worthwhile to say that big data is not a panacea or a silver bullet for all the problems related to developing a smart city. Suffice to say, it does have limitations, apart from a huge upfront cost needed for the investment in big data infrastructure and ICT devices. Such limitations can present a big challenge for everyone ranging from individual residents to firms to the government, which uses such data to make better-informed decisions.

One of the biggest issues that all statisticians and economists know about big data is that it is neither comprehensive nor representative of the entire population. Big data does not always have all the relevant information about the sample we want for a thorough analysis. For example, individual data collected from social media platforms such as Facebook is unlikely to contain details about a person's sources of income and household assets or whether or not they typically use a condom when they have sex. In such a case, researchers still need to approach the person and ask additional questions to gather necessary variables and subsequently combine them with the big data to produce meaningful findings. In addition, because big data is generated digitally, it does not include those who are digitally excluded or illiterate. As a result, the data tends to be skewed.

towards the rich, who are more educated and can afford digital devices, and youth who are more digitally literate, and those research findings deriving from the big data do not necessarily reflect the need of the poor in the smart cities. Big data and the insight produced from it should be thus interpreted with extreme caution and should not be generalized beyond the context in which it is generated.

The reliability and validity of big data can also be questionable. Like any other type of data, the value of big data lies more in its quality than in its size. If the data is not reliable or accurate, it will give misleading and harmful knowledge backfiring to any persons or firms who utilize such insight to reach a conclusion. It is not to mention any attempt by individual hackers and those who work for rival firms or countries that are secretly making every effort to contaminate the data to destroy their opponents, and this leads us to the discussion on another major challenge, namely security and privacy.

Generally speaking, data normally includes sensitive and/or confidential information related to individuals, firms, or even the government, which could be very detrimental if it falls into the wrong hands because it can be used against certain persons or organizations. There have been various reports that individual data is subject to multiple types of abusive behaviors by criminals.[22] In some instances, hackers use personal data to blackmail people or for scamming intentions causing irreparable damage financially and emotionally. Moreover, we are also facing ethical concerns over individual rights to privacy in some countries in which the government collects its citizen data without permission or the persons knowing it and uses such data to

15. Guannan Ju et al., "Smart Transportation Between Three Phases Through a Stimulus-Responsive Functionally Cooperating Device," *Advanced Materials* 25, no. 21 (June 4, 2013): 2915–19, DOI:https://doi.org/10.1002/adma.201205240.

16. N Mohamed and J Al-Jaroodi, "Real-Time Big Data Analytics: Applications and Challenges," in 2*014 International Conference on High-Performance Computing & Simulation (HPCS),* 2014, 305–10, doi:10.1109/HPCSim.2014.6903700.

17. Asian Development Bank, *Cambodia: Energy Sector Assessment, Strategy, and Road Map* (Manila: Asian Development Bank, 2018).

18. Hamory Joan et al., "Twenty-Year Economic Impacts of Deworming," *Proceedings of the National Academy of Sciences* 118, no. 14 (April 6, 2021): e2023185118, doi:10.1073/pnas.2023185118.

19. Al Nuaimi et al., "Applications of Big Data to Smart Cities."

20. Khaula Zeeshan, Timo Hämäläinen, and Pekka Neittaanmäki, "Internet of Things for Sustainable Smart Education: An Overview," *Sustainability* , 2022, doi:10.3390/su14074293.

21. P Tantatsanawong, A Kawtrakul, and W Lertwipatrakul, "Enabling Future Education with Smart Services," in 2011 *Annual SRII Global Conference*, 2011, 550–56, doi:10.1109/SRII.2011.63.

22. Chea and Ing, "International Politics of Data: Do We Need New Diplomatic Approaches for the Emergence of the New Oil?"

suppress any political rivals or objections to authoritarianism. In this sense, although some data can be collected easily, it does not mean that it should be collected or even used. Regulations related to cybersecurity and protecting individual privacy should thus be in place.

Finally, big data usually comes in a raw form or is called "unstructured." This unstructured data is useless without going through a data transformation process. Simply put, such information needs experts with cleaning or manipulating techniques to handle before it can be analyzed or modeled, which requires another set of mathematical or statistical skills. During the data cleaning process, we might also experience difficulties merging multiple different types of data that come in various structures. Not to mention any challenges of gathering the data from numerous institutions which might not share their available information since it is more beneficial for them to hoard the data. In this regard, the usefulness of big data in the smart city lies in its smart population, who will, in turn, become even smarter following the insight they gain from their refined data. However, nurturing technical experts in data is not always an easy task, even for many developed countries in Europe, which reportedly face constraints on implementing Industry 4.0 technology due to a lack of human resources.[23] In addition, as the population of the smart city expands, the size and the complexity of the data also grows, and more smart individuals will be needed.

23. Laura Bravi and Federica Murmura, "Industry 4.0 Enabling Technologies as a Tool for the Development of a Competitive Strategy in Italian Manufacturing Companies," *Journal of Engineering and Technology Management* 60 (2021): 101629, DOI:https://doi.org/10.1016/j.jengtecman.2021.101629.

Implementation in Cambodia, What's Next?

This section will cover the key components required to implement big data applications in the context of smart Phnom Penh. But before I begin, it is worth noting that the application of big data in a smart city can be classified into two broad categories, namely offline and real-time application.[24] The latter refers to big data, once instantaneously generated, which would normally require immediate and reliable data analysis and a final and timely decision regarding the results from data scientists or the leadership to use it effectively. Otherwise, it is not very important over time.[25] Such data might include financial or stock market information, traffic management, crowd control, large emergency responses during and immediately after natural disasters, military operations, etc. On the other hand, some data, such as those related to education and energy, does not typically need sudden resolutions, and they are regarded as the formers – the offline application.

Having said that already, when one desires to implement a big data application to support the development of smart cities in Cambodia, one would need to address several existing issues simultaneously. And it can only be done using holistic and integrated approaches involving many actors and stakeholders working together to solve complex tradeoffs. One will not be able to implement big data properly without any components or by addressing these challenges in isolation. Such challenges include

- Big data infrastructure: implementing big data, which is one of the latest

24. Al Nuaimi et al., "Applications of Big Data to Smart Cities."

25. Mohamed and Al-Jaroodi, "Real-Time Big Data Analytics: Applications and Challenges."

available technologies, will require a massive investment in both software, hardware, and state-of-the-art supporting physical infrastructure, including policies and laws to ensure a fruitful utilization because the size of the big data will be huge, and that demands high computing/processing power. It is not to mention that Cambodia will need many proficient data scientists and other relevant technicians to operate and maintain such infrastructure.

- Smart network traffic: big data is generated mostly from digital instruments such as mobile phones, computers, and sensors, and these devices should be capable of transferring data to the data center where big data is stored and processed, then transferred back to wherever the analytics is needed to improve the smart cities management and operations. In the context of real-time traffic management mentioned above, drivers' smartphones should be able to transfer road traffic information to the data center, which would then be processed by an expert and transferred back to the drivers to avoid traffic congestion.

- Algorithms: apart from data, smart city development and management would demand or entail sophisticated algorithms to mine and process data. Such an algorithm must be designed to efficiently accommodate a high dataset volume with different structures and types. In addition, it must be able to deal with both real-time and offline applications, which are unlikely to be employed in a similar manner or for the same purposes.

- Cybersecurity: once again, it is worth mentioning that big data conventionally comprises naturally sensitive and/or confidential information that might pose serious challenges to an individual's wellbeing and safety or even threaten national security if shared irresponsibly with other people or leaked out to the public. Not to mention any intention of misuse of the data for personal gains at the expense of other people. Therefore, a strong protection mechanism against any attempt to put data to improper use or tamper with it should be in place. The government will also need to have a serious cybersecurity system when designing and planning for the smart city's development.

- Digital literacy of the citizen: is probably the most important component here as the residents must be able to use digital devices effectively to enhance their quality of life and actively participate in developing a smart city. For that, they must be aware of the concept of a "Smart" Phnom Penh, that the government is currently implementing. After all, they are the ones that fundamentally provide the data, and better-quality data means a better understanding of how to improve different components of smart cities, including health and education. In addition, Cambodian people, especially those living in the intended smart city, must be trained to become digitally literate so that they can protect themselves from online scamming and hacking and behave appropriately on the internet. And as a result, there will be fewer problems to solve.

Conclusion

Data is arguably the new oil in the 21st century. It fuels a country's socio-economic development but can also be used as a weapon to destroy one's opponents. Having said that, data and data science have not been used to their fullest potential thus far, and there are still immense positive gains to be realised to further develop our future, smarter cities.

Research on the economics of data is also sparse overall and almost non-existent in Cambodia, in which the decision-making process rarely includes research evidence or data to support it. However, there is also a problem with the supply of data experts in the labor market who can make good use of available data.[26] On this account, the high demand for, and low supply of data scientists in Cambodia can potentially lead to the slow growth of data-driven decision making and development. This is despite the fact that the Harvard Business Review states that being a data scientist will be one of the the sexiest jobs of this century[27] - since they are both very well-paid, and in high demand.

Therefore, this paper would call for more investment in data infrastructure, research and innovation related to the economics of data, and human resources to make the smart Phnom Penh a reality. Expenses on such an enterprise should not be seen as a consumption or risky venture for any firm, since major corporations have now been relying on data to drive their businesses and make money. For now, it appears a key limitation in Cambodia is the lack of a role model to follow - one that is investing in big data facilities, that is using data to improve its customers lives, or to improve its profits, and one that could light the way for other big firms to follow.

However, I look forward to a brighter future. As these role models begin to appear (such as ABA, Wing, and more), I am confident in an innovative, data driven future for Cambodia.

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26. Sovansophal Kao, "Family Socioeconomic Status and Students' Choice of STEM Majors," *International Journal of Comparative Education and Development* 22, no. 1 (January 1, 2020): 49–65, doi:10.1108/IJCED-03-2019-0025.

27. https://hbr.org/2012/10/data-scientist-the-sexiest-job-of-the-21st-century (last visit May 23, 2022)
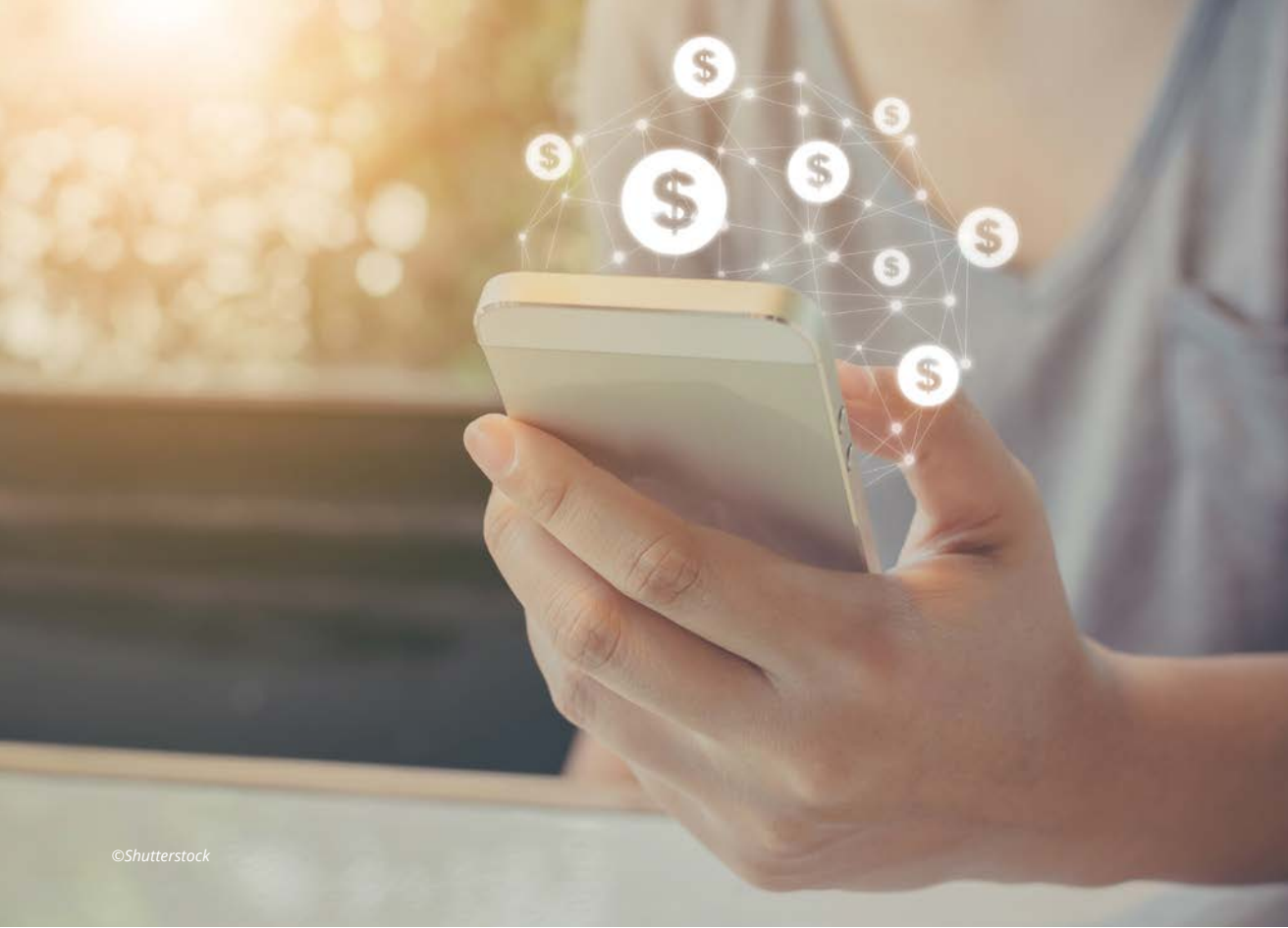
THE ROLE OF FINTECH IN FUTURE CITIES

KIM SOUNG EUNG

Introduction

The key to the cities of the future is, without a doubt, increased digitalization, as technological advancements constantly change the ways we live. From communication to commerce, technology touches every aspect of our lives; and likewise affects how we engage in banking and financial services. Online banking, in the context of Cambodia's society, was not a thing until COVID-19 happened. Only when the world was hit by the pandemic were people forced to opt for digital solutions in place of cash payments, due to the fear of infection.[1] Many financial technology (Fintech) solutions, thereby, experienced a boost in activity levels. Coming with this trend is the notion to rethink the world of digital finance. Hence, what does the future hold for financial services, and how can fintech improve urban living?

This article aims to explore the possibility and diversity of fintech solutions that would be indispensable in driving a smart city. On this account, key definitions and concepts of financial technology will be introduced. The paper will then discuss the roles of Fintech in future cities by presenting two promising aspects of fintech solutions: (i) smart payment and (ii) smart banking.

Financial Technology

Though there is no formal definition, short for financial technology, Fintech is a term used to generally describe financial services and products that are delivered with technology.[2] Often widely perceived as a brand new concept, depicted as blockchain,[3] Fintech is more than just a cutting-edge technology of financial services that has just emerged. It also encompasses simple financial applications that have long existed since the late 19th century;[4] examples of such include deposits and withdrawals through automated teller machines (ATMs), and payments via credit and debit cards. In short, Fintech refers to everything from digital payments, to digital wallets, "to crowdfunding platforms, to robo-advisors, to virtual currencies."[5]

Financial technology has evolved from simple everyday banking services to personal finance and trading via mobile devices. Nonetheless, integral to these services, be it the complex distributed ledger technology that backs the blockchain or the simple mobile banking, is the effort to provide consumers with convenient and efficient financial solutions.

The Roles of Fintech in Future Cities

Contactless payment has become the new normal payment method on account of COVID-19. The majority are opting for scanning QR codes or transferring through mobile apps from smartphones for its convenience and flexibility. Nonetheless, a trend that happened rapidly following the outbreak will undoubtedly not cease, but rather grow promisingly, in the post-pandemic era. Global cashless transactions are estimated to triple in volume, from

1. "Cambodians are going online for a more convenient and safer shopping experience," *Visa,* September 07, 2021, https://www.visa.com.kh/en_KH/about-visa/newsroom/press-releases/cambodians-are-going-online-for-a-more-convenient-and-safer-shopping-experience.html

2. "Fintech," CFA Institute, https://www.cfainstitute.org/en/research/fintech

3. "Fintech (Financial Technology)," *CFI,* http://www.corporatefinanceinstitute.com/resources/knowledge/finance/fintech-financial-technology/

4. Douglas W. Arner, Janos Nathan Barberis, and Ross P. Buckley, "The Evolution of Fintech: A New Post-Crisis Paradigm?," *SSRN Electronic Journal* (2015), https://doi.org/10.2139/ssrn.2676553

5. "What is fintech? | CNBC Explains," CNBC International, June 8, 2018, educational video, 0:29 to 0:32, https://youtu.be/-EoNrg_DR3s

1,035 billion in 2020 to 3,026 billion in 2030. And the fastest growth is expected to be in the Asia-Pacific region, which amounts to 60 percent of the total projection in 2030.[6] Cambodia is no exception to this aspect, with digital payments expected to double in value from USD 4 billion in 2022 to USD 7.4 billion in 2026.[7] A look at numbers shows an acceleration in smart payment growth as people begin to embrace technology and seek a time- and cost-efficient payment system. Thus, pertaining to the future of cities, in an effort to foster the efficiency of urban living through smart cities, the adoption of smart ecosystem payment is inevitable. On that account, we will introduce the roles of fintech in future cities by dividing it into 2 main categories: (i) smart payment; and (ii) smart banking.

Smart Payment

With the growing urban population comes cumulative payment flows in the economy. Hence, unlocking a smart city undoubtedly requires smart payment solutions that can handle large money flows (streams of transactions) efficiently. That is, for a city to become smart, its payment system infrastructure must likewise be smart. The question lies in how payment systems can be intelligent. It would need to be not only secure and transparent but also seamless and instant. This is when Fintech comes into play.

Digital payments can be a one-stop solution that eases the movement of money in the fast-moving urban space. Fintech can enable a convenient and quick payment method with just the tap of a card or a mobile phone. By doing so, Fintech connects all the players in the city to a single central point under the context of payments, including consumers, merchants, governments, financial institutions, and NGOs.[8] Use cases of digital payments for the city governments are collections of taxes and transit fares,[9] healthcare and social services, tourist places, penalties, subsidies, and benefit programs.[10] Meanwhile, consumers and merchants can use it for sales purposes.

Furthermore, transactions through electronic payment (e-payment) ensure not only convenience to accommodate the fast-moving population, but also security. Digital payments are secure for the reason that it utilizes secure and encrypted one-time password (OTP)[11] as well as other multi-level authorization and authentication requirements, such as biometrics (voice, fingerprint) or facial recognition. Thus, the future of payments will be highly dependent on technology to make the payment process easier, quicker, and safer.

Living in an inclusive smart city with a smart payment infrastructure, inhabitants do not have to worry about the hassle associated with cash payments. Such cases include not having enough cash or small changes in their pockets; having to spend time waiting to pay or get the change when you are already running late for a meeting or spending time and travel expenses to pay for obligatory payments such as tax and fines. These concerns can be tackled by the introduction of smart payments. Manual physical payment activities would be eliminated, whilst cards or smart devices are employed to assist users in transaction completion.

In short, in the future cities, not only will digital payments become prevalent, but also self-service payment solutions. Such Fintech payment solutions may include, but are not limited to, the following: :

- online payment via mobile phones through an app in which payment gateways can be connected to a bank account;

- an ATM to make payments with a debit or credit card; or

- a pay-as-you-go (PAYG) or tap-and-pay machine in which NFC and/or QR Code are enabled for making cashless payments. Such payment tools include cards and smart devices such as smartphones or smartwatches.

Smart Banking

Big Data and artificial intelligence (AI) are anticipated to become important tools in designing products that are tailored for each consumer with distinctive habits and lifestyles. These tools, likewise, are important for the banking sector where human work would be minimized as much as possible for operational efficiency and consumer value proposition purposes.

The adoption of AI in the banking and financial industry will introduce the users to a whole new experience of engaging in banking services and products. As much emphasis is placed on efficiency maximization and human-centered design in smart city projects, customer-oriented and personalized services and products of the banking sector should also be accentuated. Rather than branch visits for an over-the-counter (OTC) discussion with staff to decide on a one-size-fits-all product or service subscription, AI technologies should be deployed to deliver a tailored-made product and compelling customer journey for the users. Technologies, such as Big Data; AI; Machine Learning, can be applied to banking products in the same manner as big media corporations—YouTube[12]; and Netflix[13]— use to automatically generate personalized content recommendations for users. The promising prospect of contactless payments presents respective banking and financial institutions (BFIs) with free and accessible data through customers' past transactions history. These data, along with AI technologies, can then be harnessed to recognize customers' spending patterns as well as to predict their preferences and potential needs. By replacing conventional market research with AI-based applications, BFIs can design and introduce new products that align with the customer demand at a faster pace, improving user experience.[14]

6. PwC, "Payments 2025 & Beyond," PwC, https://www.pwc.com/gx/en/financial-services/fs-2025/pwc-future-of-payments.pdf

7. "Digital Payments - Cambodia," Statista, https://www.statista.com/outlook/dmo/fintech/digital-payments/cambodia

8. Mastercard, "Smart Cities are Connected Cities," Mastercard, April, 2017, https://www.mastercard.fr/content/dam/public/mastercardcom/na/us/en/governments/others/smart-cities-connected-cities-brochure-april-2017.pdf

9. Ibid.

10. Vivek Belgavi, "Creating Smarter Cities through Digital Payments," PwC, November, 2017, https://www.pwc.in/assets/pdfs/consulting/financial-services/fintech/point-of-view/pov-downloads/payments-newsletter-creating-smarter-cities-through-digital-payments.pdf

11. Citibank, "Manual and Electronic Payment Security Best Practice," Citibank, January, 2018, https://www.citibank.com/tts/sa/emea_marketing/docs/Manual_and_Electronic_Payments.pdf

12. Bernard Marr, "The Amazing Ways YouTube Uses Artificial Intelligence And Machine Learning," Forbes, August 23, 2019, https://www.forbes.com/sites/bernardmarr/2019/08/23/the-amazing-ways-youtube-uses-artificial-intelligence-and-machine-learning/?sh=726a26025852

13. Allen Yu, "How Netflix Uses AI, Data Science, and Machine Learning — From A Product Perspective," Becoming Human: Artificial Intelligence Magazine, February 27, 2019, https://becominghuman.ai/how-netflix-uses-ai-and-machine-learning-a087614630fe

14. Dick Fong, Feng Han, Louis Liu, John Qu, and Arthur Sek, "Seven technologies shaping the future of fintech," McKinsey & Company, November 9, 2021, https://www.mckinsey.com/cn/our-insights/our-insights/seven-technologies-shaping-the-future-of-fintech

Eden, a customer, pays for her coffee using her smart devices—a mobile app and smartwatch. The bank app, through previous transaction history, recognizes her spending habits and suggests an automatic payable feature when she is at the coffee shop she goes to regularly. Eden can then either use biometrics (voice, fingerprint) or facial recognition to complete the transaction. Moreover, with the data, the bank app can recommend Eden analytics-backed personalized saving offers or plans that are based on her spending patterns.

A real-case example is HSBC bank which recorded a 40 percent surge in usage after employing a data-driven AI model to propose personalized reward programs related to travel; shopping; and so on.

In short, technologies play a pivotal role in providing better experiences for both the banks and the customers. AI-based automation and analysis, beyond operational efficiency, can assist banks in creating targeted products that are in line with customer needs, enhancing customer experiences, which translates into increased sales and firm values. Whereas, customers can enjoy more diverse and fitted products, earning greater satisfaction.

Fintech in Cambodia

Table 1. *Leading Fintech Innovators in Cambodia*
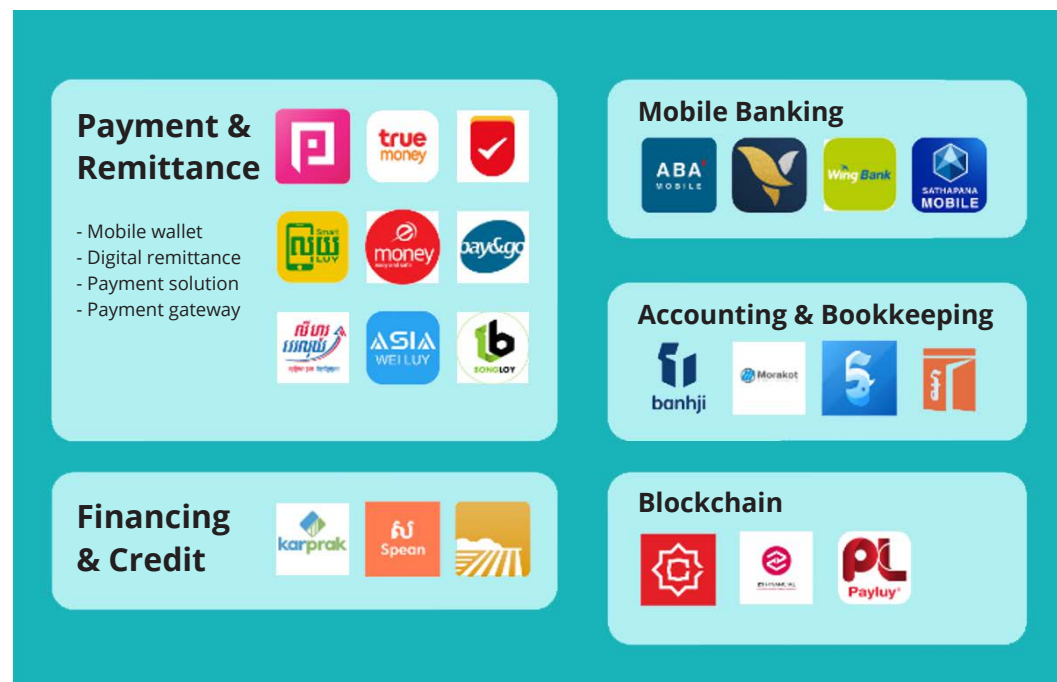
Conclusion

It is almost impossible to visualize a smart city without smart finance. Payments, the movement of money, are imperative to the economy; and economic growth, in turn, drives a country's development. Thus, to develop a smart city, having a smart financial infrastructure that would assist the urban population concerning the urban living experience is a must.

Fintech solutions may need no complex or high-end technologies; yet, at its core should be making our lives simpler, quicker, safer, and smarter. With that intent, fintech solutions should be designed to provide speed, cost, and operational efficiency for the cities and their inhabitants. A smart city is a connected city whereby financial and banking services are seamless and contactless whilst security and safety are ensured.

Looking forward, Fintech is the driving force of an inclusive and sustainable smart city.

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USERS ARE THE WEAKEST LINK FOR CYBER CRIMINALS – ARE CAMBODIAN YOUTHS READY FOR CYBER THREATS?

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DARAVICHET TIN

SIRIWAT CHHEM

M A HOSSAIN

Introduction

Smart cities initiatives have already started to become a reality as many aggregated technologies have been implemented with an aim to improve the living standards of the inhabitants of the cities. A sustainable smart city would mean that the city is cyber-secured. However, cybersecurity issues have increasingly become a serious issue in cyberspace, threatening the objectives of achieving sustainable and robust smart cities. According to the Ponemon Institute study, the cost of a data breach has risen from USD 3.86 million to USD 4.24 million in 2021.[1] The most prominent cause of cyber security breaches is end-users. Based on IBM's X-Force Threat Intelligence Index 2022, 95 percent of the cyber security breaches are caused by human errors.[2] Cybercriminals exploit the psychological vulnerability of humans by influencing them to commit actions that could expose the digital infrastructure of their institutions to cyber-risks. Internet users habitually commit the following blunders in cyberspace, such as:

- Using predictable passwords that can be easily exposed to cybercriminals.

- Clicking on suspicious attachments and phishing links that are attached through SMS messages, pop-ups, emails, websites, online games, and other social networking activities

- Downloading and installing software programs that contain malware.

- Using public Wi-Fi to gain access to essential services applications such as online banking services which could potentially allow cybercriminals to infiltrate the system.

This issue has imposed significant risks on societies that are increasingly connected to the digital world, including Cambodia.

Cambodia has seen rapid growth in mobile devices and Internet usage in recent years. According to Datareportal, by 2021, Cambodia had 21.18 million mobile connections in January 2021, a 0.9 percent increase from the previous year.[3] On the other hand, the number of Internet users had reached 8.86 million, an increase of 1.1 million (14 percent) from the previous year.[4] These figures have shown that the Cambodian population rapidly connects to the Internet and other networks. However, the significant increase in the number of people accessing the Internet does not guarantee that the users are well-equipped with digital skills to tackle cybersecurity threats and issues. New forms of cyber-related crimes and activities and the lack of digital skills have posed a significant threat to Cambodia's fragile security infrastructure. This includes security risks related to social engineering, phishing, passwords, online banking, e-commerce payment systems, ransomware, hacking, etc.

This paper presents an investigation to explore digital readiness among Cambodian youths, particularly to know if they are sufficiently equipped with digital awareness and knowledge in order to protect themselves on email, network, social media, and other digital platforms. For there to be smart cities, the people who live in them must be capable of adopting wise online behaviors and making wise decisions. The research question of the paper is: how

1. Cost of a Data Breach Report 2021. IBM. 2022. https://www.ibm.com/security/data-breach
2. X-Force Threat Intelligence Index 2022. IBM. 2022. https://www.ibm.com/security/data-breach/threat-intelligence/
3. Kemp, S. Digital 2022: Cambodia. 2021. https://datareportal.com/reports/digital-2021-cambodia
4. Ibid.

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DIGITAL INSIGHTS

digitally ready are Cambodian young people to tackle cybersecurity issues? At the end of the paper, there will be important recommendations on what approaches should be taken by all involved stakeholders in order to increase Cambodia's next generation's digital skills in cybersecurity.

Methodology

The survey was distributed to Canadian International School high school students and to freshly graduated high-school students from different parts of the country including Phnom Penh, Battambang, Siem Reap, Kampong Cham, Pursat, Takeo, Ratanakiri, Kampong Chhnang, Banteay Meanchey, and Kampot. The total number of respondents was 170. The questionnaire is already designed to elicit information about participants' knowledge of passwords, phishing, ransomware, fake software, hacking, social media, and social engineering security. Table 1 below shows the questionnaire that all the respondents were asked to fill out. The questionnaire contains a total of 24 general recommendations which could protect the individuals from cyber-related crimes and activities on digital platforms. Respondents either selected "Yes" or "No" based on their awareness or knowledge of the recommendations.

1. Don't share your password with anyone including close family members. Never reveal passwords or other personal information to unverified apps or services. Reset passwords, at least once in a year. Don't use any name or numbers or easily predictable password. Don't use the same password for different organisations/companies. Use a minimum 10 characters long password with a combination of letters, numbers and symbols.

2. Don't use unsecured WiFi connections (e.g, in a hotel) for financial and other sensitive personal information exchange. Turn off your WiFi connection if you are not using the Internet to avoid others tracking you.

3. Don't use a memory stick before you make sure it is free from virus or malware. This may infect your machine, track your activities or even access to the files in your computer or personal devices.

4. Use online scanning tools such as 'Virustotal' (https://www.virustotal.com/) to analyse suspicious files and URLs.

5. Don't send sensitive information (e.g, account number, credit card information etc.) via email for an unknown request.

6. Don't update personal information or credit card details through a link received via an email or unknown website.

7. Don't click unknown web links received through emails or social media.

8. Don't download unknown email attachments. Verify email addresses using Google and make sure (via a phone call) it is from a genuine organisation or individual. Use sandbox tools such as Sandboxie (https://www.sandboxie.com/) if you suspect that a downloaded file may contain a virus.

9. Verify a website (through black listed URL testing or a phone call) before providing credit card information to buy through an unknown website. Otherwise you may lose money if it is a fake site.

10. Verify the website security certificate- look for https. Check https by moving your pointer on top of the https link to ensure that there is no hidden URL behind this.

11. Verify an email or text message to avoid CEO fraud – If your boss asks you to send money urgently via an email or text message, please verify (via direct phone call or face to face meeting) before doing so. This is to ensure that his/her account has not been hacked.

12. Update your software (including anti-phishing) and tools to reduce cyber-attacks. Run a virus, adware and malware to scan regularly with your installed security software. Report suspicious activity to these companies to improve their scanner.

13. If you see a pop-up (an unexpected advert) during video streaming, online gaming or browsing unknown websites, don't click OK or Cancel. In either way, your click may download malware, spyware, virus or other harmful code. Use 'Adblock' software to reduce the risk and unwanted advertisement.

14. It is recommended to back up all documents to offline storage that can't be affected by ransomware (a piece of software that demands money by encrypting your files or screen).

15. Check data breaches of your online accounts using 'haveibeenpwned' (Link: https://haveibeenpwned.com/)

16. Use a standard user account instead of an administrator account, so that the cyber-attackers will have limited access to your systems.

17. Set your user account control (UAC) settings to the highest level.

18. Disable java content in your browser to protect from browser exploits.

19. Utilise Microsoft's EMET Toolkit to fine-tune security features.

20. Enable the privacy settings through privacy features that your social media sites offer you to control privacy such as who can see your personal information, photos, and posts

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21. Update your social media applications periodically. Make sure that you are logged into the official website of the apps.

22. Avoid fake apps by carefully reviewing your social media wall for apps offered through reading the apps reviews and list of permissions requested by the apps.

23. To avoid frauds that are built based on what you are interested in or what you post, do not click on links that are sent to you through crafted messages.

24. Know and manage your friends and followers, because some cyber criminals post content to encourage you to link to fraudulent activities or phishing websites.

Response: ■ Yes ■ No

Findings and Analysis

Due to the large number of missing values, we removed the data from the dataset by setting the limitation of the missing value to at most one so that it would not affect the analysis model. As a result, we were able to acquire data from 91 respondents out of the total 127 in the data set. We subdivided the 24 recommendations in the questionnaire into two categories: the "technical" and "non-technical" recommendations. The technical recommendations are recommendations for cyber-protection in which the users need to handle the external applications, programs, as well as internal settings of their devices, and vice versa for the "non-technical" recommendations. The "non-technical" recommendations include #1, #2, #3, #5, #6, #7, #9, #11, #22, #23, #24; while "technical" recommendations include #4, #8, #10, #12, #13, #14, #15, #16, #17, #18, #19, #20, #21. The findings from the questionnaire are summarized in Table 2 below. In all of the recommendations, more respondents positively responded that they have more knowledge of the recommendations than those who do not, except for recommendation #4 (Use online scanning tools such as' Virustotal '(https://www.virustotal.com/) to analyse suspicious files and URLs), #15 (Check data breaches of your online accounts using 'haveibeenpwned' (Link: https://haveibeenpwned.com/) #17 (Set your user account control (UAC) settings to the highest level), #18 (Disable java content in your browser to protect from browser exploits), #19 (Utilise Microsoft's EMET Toolkit to fine-tune security features). However, the ratio of the respondents who responded negatively is significantly higher in #10, #14, and #16 as well in which the number of negative responses surpassed half of the positive responses The results we obtained in #4 and #15 show that the respondents lack awareness of the external tools and sources that they can use online in order to validate the links and attachments that they receive online. The significant negative responses from # 16 # 17 # 18 # 19 also imply that the respondents also lack knowledge of the security mechanisms existing on their devices.

However, the respondents provide positive responses to recommendations #5 to #9. These recommendations are specifically about phishing and potential threats that they may encounter through emails. A lot of respondents also responded positively to recommendations # 20 to # 24, which concern best practices that can be used on social media
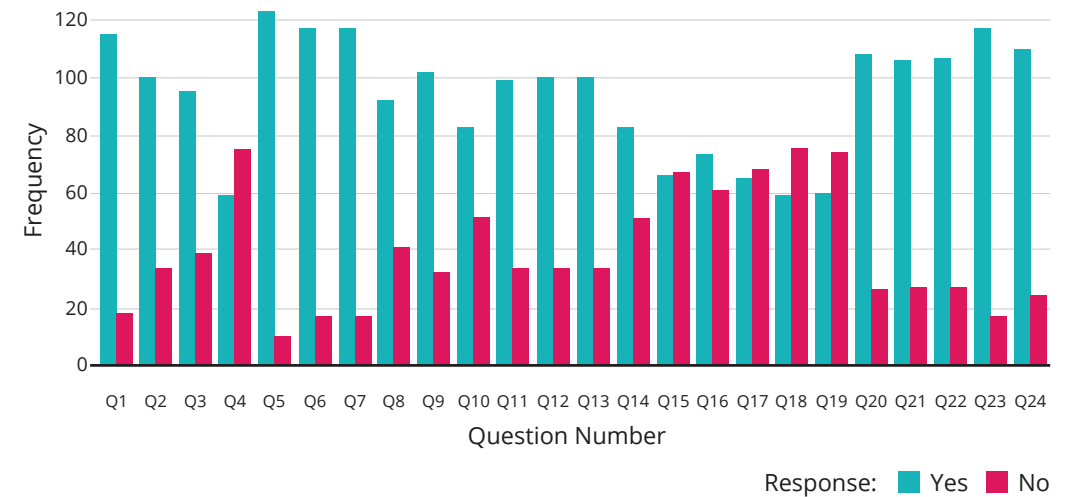
platforms. These results imply that most of the respondents are exposed to self-protection practices on communication platforms such as email and social media. Overall, it can be seen that more respondents responded positively to "non-technical" recommendations compared to the "technical" recommendations.

Recommendation

Solving cyber-related issues requires efforts and commitments across several stakeholders, such as governmental institutions, private companies, universities, and individual communities. In order to ensure that Cambodia's young generation is well-equipped with essential digital skills and readiness to protect themselves in cyberspace and strengthen the cybersecurity infrastructure, each stakeholder should consider the following recommendations:

- The government should prioritize establishing a national cybersecurity center whose primary focus is to educate and train an existing task force that monitors cyber-related issues and crimes as well as develop experts to take rapid action if issues were to arise.

- Universities should establish academic and research programs that focus on producing specialized professionals, particularly in cybersecurity fields such as "Cybersecurity," "Forensic Computing," and "Network Management."

- Collaboration should be endorsed and encouraged among private companies, governmental institutions, and universities to ensure that basic awareness and safe practices in cyberspace can be developed, improved, and shared among people of different backgrounds.

Conclusion

This paper has presented the results of the investigation into the digital readiness of Cambodian youths in cyberspace. The objective of the paper is to understand whether Cambodian high school and university students are equipped with basic digital awareness and knowledge necessary in order to protect themselves on online platforms such as email, networks, and social media. According to the papers' findings, the majority of young people in Cambodia are aware of some of the recommendations made in the questionnaire, such as those that advocate for best practices when using email and social media. However, it is also noted that most of the respondents also lack awareness of certain tips that are related to their existing systems and programs on their devices that can be used to strengthen their protection online. Additionally, most of the respondents also lack awareness of existing external sources which they can use to protect themselves as well, i.e., online scanning tools or websites which identify potential risks for the users. These drawbacks can be remedied with the recommendations suggested in the above section. Efforts and commitments from stakeholders such as the state government, private enterprises, universities, and individual communities are important to ensure that the Cambodian youths are fully equipped with digital awareness and knowledge to protect themselves in cyberspace. Having smart citizens who are well equipped with cybersecurity skills and knowledge could ensure that smart cities would be safe and secure from cyber-related attacks and crimes.

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FUTURE CITIES – A FUTURE CITY MUST ONLY MONITOR ITSELF AND NOT ITS INHABITANTS

ARONSAKDA SES

At the turn of the 2040s, the digital revolution brought forth an unprecedented transformation to Cambodian towns and cities. The kingdom's policy makers had chosen to pursue a citizen-centric, Information Communication and Technology (ICT) driven and privacy minded approach to digital infrastructure. Contributions to the management, planning and evaluation of urban centers are not just the realm of experts and technicians, but also of passionate citizens like Thealy.

Sitting comfortably in her home, Thealy remotely monitors a newly implemented cycling route in Phnom Penh. At her disposal is a vast pool of sensors, examining rider count, frequency, speed and rider grouping. She has also tapped into atmospheric sensors monitoring air quality, temperature, humidity and noise level along the route.

The data captured is anonymous and does not compromise an individual's privacy. Moreover, the data is open source; made available to the public for the purpose of education and research. And Thealy is doing exactly that, her thesis explores the impact environmental factors have on cycling ridership across Phnom Penh.

Thealy realizes just how instrumental the network of sensors has been for her work and the work of so many others; be it students completing a high school project, universities and institutions writing research papers and businesses keeping track of orders. The ubiquity and free flow of data is possible because the Phnom Penh Thealy lives in is an example of a smart city made possible by the digital revolution of decades past.

In the second half of the 2020s, Phnom Penh's municipal authority prioritized the implementation of a city-spanning monitoring and data sharing network, as part of the greater transformation of the capital towards a smart city. The digital revolution promised to put sensors into everything and connect them in a wide spanning network; sharing data between each other and their host.[1] The future of cities looked exciting.

Many argued that a smart city will revolutionize monitoring, research, management and policy formation for urban areas. City planners and researchers can gather data on the broadest spectrum or on the most minute detail; all in real time. No observation will be too broad, no detail too obscure, no data collection too long and costly.

Yet the specter of such technology being used to stifle personal freedom and privacy looms.[2] Given the urgency of the endeavor, its implementation worried many, especially regarding its impact on privacy and society as a whole.

Thealy is fully aware of the challenges Phnom Penh had gone through in order to implement a system that is respectful to her and her fellow citizens' privacy, while remaining a useful and accessible tool for research.

What was needed was policy to guide its implementation. It needed to be productive and insightful—more than just a gimmick, it needed to be transparent and accessible—

1. Stefan Poslad, Athen Ma, Zhenchen Wang, & Haibo Mei. "Using a Smart City IoT to Incentivize And Target Shifts in Mobility Behavior--Is It a Piece of Pie?" *Journal of Sensors 2015,* 15(6). (Multidisciplinary Digital Publishing Institute, 2015): 13069-13096.

2. Finch Kelsey, Omer Tene. "Welcome To The Metropticon: Protecting Privacy In A Hyperconnected Town." *Fordham Urban Law Journal,* Volume 41, No.5 Article 4. (2016): 41: 1581.

not a black hole of data, and it needed to be respectful to inhabitants—avoiding becoming a mass surveillance tool.[3]

This was the exact thought a group of researchers, city planners and policy experts were thinking at the beginning of the 2020s. They sought to avoid the negative implications and harness the benefits of a city-wide digital information network. Their collective voice and expertise sought to steer the implementation of the smart city from a policy perspective.

Together the group formulated a data protection act, and the first principle of this act was a policy of data anonymity. Data which is insightful and productive for researchers does not need to contain Personally Identifiable Information or PII, which are personal details or information that permits the identity of an individual by either direct or indirect means.[4]

Instead it should focus on providing data that is utilitarian; only the condition, performance and quality of the piece of infrastructure and not the people who use them. Thus allowing users to remain anonymous.

For example, transportation planners only need to observe a street's flow capacity, the number of commuters, their direction of travel and speed, etc. They do not need to know the appearance and personal details of commuters. To this end, the data protection act outlines technology which captures the utilitarian nature of the city and does not degrade privacy.

Consequently, in the field of urban mobility Phnom Penh embarked to install motion sensors to detect active commuters waiting at crossings and automatically activating traffic lights to allow their passage. The city installed crowd sensors at transit stations to measure crowdedness and allow for appropriate adjustments to train and bus schedules. GPS systems were integrated into buses and trains to allow real-time public transit tracking. Rider and pedestrian counters are commonplace along routes and paths, quietly monitoring local road capacity, usage and warning users and authorities of any congestion.[5]

Although the prevalence of sensors sounds overbearing, Thealy recalls that they are not intrusive. A cyclist herself, she frequents many of the routes she monitors, as part of her daily commute, and never has she been irked out by the fact that herself along with everyone else walking and cycling are being monitored in real time.

She is confident in this knowledge because the robust policy set up decades ago highlighted technology which damages privacy and should therefore be avoided. Devices like CCTV, facial recognition software, IMSI catcher or similar devices which harvest data from personal electronic devices are prohibited.

As she rides across a tree lined cycling path, she knows that her right to privacy is preserved. Only motion sensors are used to count her as a rider. Her appearance is not recorded by cameras. And her electronic

gadgets are not being harvested for personal information. In fact, the system only notes that she is the 1424th rider to have passed through this section of cycling track today.[6]

This way the anonymity of the data is preserved; masked in a collective bundle without personal identifiers. To anyone monitoring, she is simply another rider along a busy cycling path.

As part of her study, Thealy also examines the environmental factors present on each cycling route. And luckily for her, it is not just the street network that Phnom Penh's sensor array monitors, it also covers many aspects including climate, energy and water usage.

On the environmental side, Phnom Penh had installed rainwater monitors along rooftops, streets and parks. A network of remote thermometers measures ambient temperatures across the city; giving precise readings down to every street corner. Sensors for humidity, air quality and UV exposure are also ever-present along roads and public spaces. Forming a city-wide climate watch, feeding the analytics to not only government institutions and businesses, but also the work of curious individuals like Thealy.[7]

After scrutinizing and tabulating environmental data from several cycling routes across Phnom Penh, Thealy discovered that the most popular routes were several degrees cooler, had lower UV exposure and much improved air quality. She has a hunch as to why—street trees.

To confirm her new hypothesis, she quickly brings up data of urban flora coverage, recently compiled by a local environmentalist group, and cross tabulates with the climate data along the busiest cycling routes. Thanks to the open source nature of data and the universal digital architecture shared by all monitoring systems, accomplishing such a complex task was relatively easy for Thealy.

This is in part thanks to the forward thinking policy enacted by her predecessors, which has ensured that the software side of the smart city network was built on the same digital architecture. Ensuring smooth and easy transition from one set of data to another. It had also allowed private individuals, technicians, civil society, media and academics alike to add additional resources onto the digital network on their own accord—a citizen-centric and ICT facilitated approach to generating and sharing data.[8]

And this was the second core tenant of the data protection act. Policy makers identified the implementation of an open-source data ecosystem, utilizing a universal digital architecture as crucial for a productive and inclusive digital ecosystem.[9] This also meant that the system can be continuously upgraded and added upon by other collaborators, building an increasingly extensive network overtime and having the flexibility and room to adapt to future needs.

"Enough musing around", Thealy reminded herself. The analysis she compiled earlier has been completed.

3. Steve Wilson. "The Collision Between Big Data and Privacy Law." Australian Journal of Telecommunications and the Digital Economy (2014): 2 (3).

4. "Guidance on the Protection of Personal Identifiable Information." U.S. Department of Labor. Access date 29th April 2022: https://www.dol.gov/general/ppii#:~:text=Personal%20 Identifiable%20Information%20(PII)%20is,either%20direct%20 or%20indirect%20means

5. Sam Musa. "Smart City Roadmap." Academia (2016): 3

6. Mark Ames. "Counting Bikes on London's Cycle-Only Street." Smart Cities Dive, Accessed 29th April 2022: https://www. smartcitiesdive.com/ex/sustainablecitiescollective/counting-bikes-londons-cycle-only-street/171891/

7. Duncan McLaren, Julian Agyeman. *Sharing Cities: A Case for Truly Smart and Sustainable Cities.* (Massachusetts: MIT Press, 2015), 58.

8. Vito Albino, Umberto Berardi, Rosa Maria Dangelico. "Smart cities: Definitions, dimensions, performance, and initiatives." *Journal of Urban Technology* 22(1) (2015): 3–21.

9. Nisenbaum, Amit. "What's Holding Smart Cities Back?". *Scientific American Blog Network,* (2019). Accessed 25th of April 2022: https://blogs.scientificamerican.com/observations/whats-holding-smart-cities-back/

Her analysis has found that well shaded streets, courtesy of trees, are the most popular cycling route for riders in Phnom Penh. As evidenced by crossing tabulating traffic data, environmental indicators and urban flora resources. The ability to quickly and effortlessly migrate and cross tabulate data between different fields of studies has proven to be an indispensable feature for her.

With the result of her study completed, Thealy moves to document them. Within a few weeks, her report will be published at an open source portal for Cambodian sustainable mobility practitioners. The insights she compiled are also easily transferable for others to further study and validate.

Her research has come full circle. It started as a collection of open source data, was gathered and analyzed by an individual, and the results of which have been released into a free flowing data ecosystem. Similarly, many like her are doing the same, utilizing the extensive ICT driven, city-wide sensor network to further their own endeavors; adding to the depository of knowledge which facilitate efficient decision making between city authorities, external organizations and citizens in a highly collaborative, transparent and citizen-centric digital ecosystem.

Correspondingly it drives a culture of informed and evidence-based decision-making in the governance and management of Phnom Penh, which is a key dimension of a smart city enabled and supported by real-time data collection, sharing and analytics.[10]

When speaking at the annual Phnom Penh urban mobility forum, Thealy spoke of how real-time and comprehensive monitoring, collection and sharing of data have allowed even a single individual to contribute meaningfully to the management and planning of the city. All the more crucial that these capabilities do not compromise citizens' privacy.

Phnom Penh treaded carefully in striking a balance between the allure smart city promised and the danger it posed. Policies to ensure data anonymity through preventing the recording of PII and the adoption of an open source philosophy for data through a universal digital architecture, have ensured that Phnom Penh lived up to its aspirations as a smart city.

Thealy ended her discussion by stating, "If you can't measure a city, then you can't manage it."

10. David Mills, Steven Pudney, Primoz Pevcin, Jaroslav Dvorak. "Evidence-Based Public Policy Decision-Making in Smart Cities: Does Extant Theory Support Achievement of City Sustainability Objectives?" *Sustainability 2021*, (Multidisciplinary Digital Publishing Institute: 2022): 14(1).

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EDUCATION

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PREPARING CHILDREN FOR SMART CITIES:
Incorporating Digital Literacy Into The Early Childhood Education

PICHPISEY SOVANN

PHASOKVINA SAR

Introduction

With the advancement in technology over the years, children live in a world enriched by smart phones and computers. Prior to COVID-19, we had no idea that learning could be conducted fully online, and could not have predicted the increase in quality educational content now prevalent on streaming platforms such as YouTube. The domination of technology in our everyday lives highlights the importance of digital literacy, not just for adults but also children. As half of the worlds population is online, including 70 percent of 15- to 24-year-olds,[1] it is clear that obtaining capabilities to make use of digital opportunities and of the internet is a great benefit.[2] Children who spend more time online are exposed to advantages and disadvantages of being online.[3] Digital practices for children can provide valuable opportunities for them to learn and interact in the society and benefit from the interactions.

Accessibility is one criteria to consider to ensure the future generation's active and safe engagement in digital environments. Digital literacy is as necessary as other basic skills for children to equip themselves to utilize digital technologies. Digital literacy is defined as an individual's ability to "access, communicate, integrate, communicate, evaluate, and create information" in a digital infrastructure or with digital technologies with safety and security in mind.[4] In 2017,

the United Nations Children's Fund (UNICEF) set a goal to "teach digital literacy to keep children informed, engaged and safe online" through the implementation of digital literacy programs in a holistic way.[5] Introducing digital literacy early to children is a tremendous investment in their future as a smart citizen.

This paper aims to identify existing definitions of digital literacy and the contexts in which they were developed, the most-used competence frameworks and approaches, and the steps to incorporating digital literacy in early childhood education. The paper further suggests policies to develop digital literacy for children at the pre-primary level that will allow them to innovate, decide, and thrive in the future Cambodia.

Early Childhood Education in Cambodia

Historically, religions played a fundamental role in educating both children and adults. In the UK, the National Society established in 1811 aims to make religion the foundation of education. Churches have accommodated education since then.[6] Likewise, influences of Buddhism in education in Cambodia can be traced back to as early as the twelfth century from which education took place in Buddhist temples taught by monks up until the French colonization in 1863.[7] In the early 1980s, the entire educational system from pre-primary to higher education was revisited with a total enrollment of nearly one million.[8]

1. International Telecommunication Union, "Measuring the Information Society Report 2017," n.d., https://www.itu.int/en/ITU-D/Statistics/Pages/publications/misr2018.aspx.

2. Organisation for Economic Co-operation and Development, *OECD Future of Education and Skills 2030* (Paris, n.d.), https://www.oecd.org/education/2030-project/.

3. UNICEF, *Digital Literacy for Children: Exploring Definitions and Frameworks,* 2018, https://www.unicef.org/globalinsight/media/1271/file/%20UNICEF-Global-Insight-digital-literacy-scoping-paper-2020.pdf.

4. Ibid.

5. UNICEF, "The State of the World's Children 2017," 2017, https://www.unicef.org/reports/state-worlds-children-2017.

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7. David P Chandler, "Cambodia," in *Encyclopedia of Asian History,* 1st edition (New York : London: Charles Scribner's Sons, 1988), 219.

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Learning should take place after a child is born. It is important to cultivate nurturing, stimulating, and secure learning environments through interactions with humans before children begin their schooling journey. The United Nations Economic, Scientific and Cultural Organization (UNESCO) conceptualizes the coverage of early childhood development and care to begin from birth to the age 8.[9] Learning from birth is advantageous for a child's future learning and growth. Children learn through questioning and experimenting through manipulations of objects while exploring new objects with trials and errors. Bronfenbenner suggests that culture and environment to which children are exposed shape their learning (See in Figure 1).[10] As of now, children who go online are exposed to a number of new environments, not limited to the physical ones.

Figure 1: Bronfenbrenner's bioecological model of human development
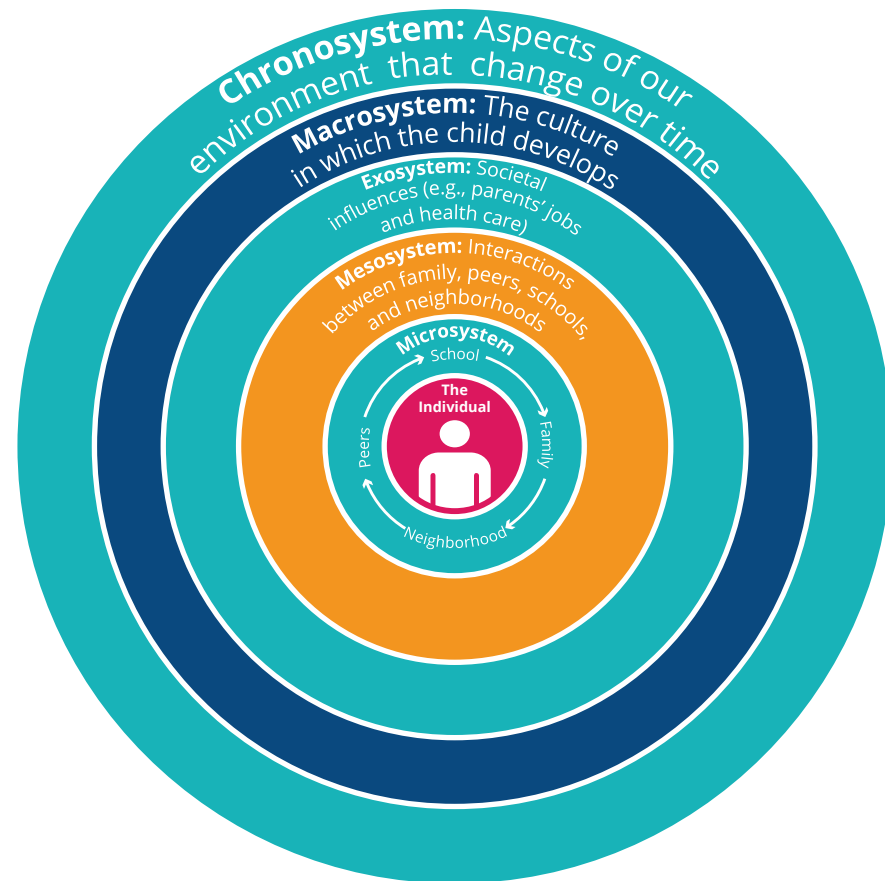
Source: Pearson

The International Standard Classification of Education (ISCED) categorizes education programmes and related qualifications by education levels and fields. The latest version of the classification, developed in 2011, has nine levels of education, from level 0 to level 8. ISCED 0 refers to early childhood education and is further classified into two categories: early childhood educational development (ISCED 01) and pre-primary (ISCED 02).[11] ISCED 0 refers to the support for children's early "cognitive, physical, social and emotional development".[12]

Early socialization, preparation for other levels of schooling, and basic literacy are important aspects of early childhood education. As of 2021, 5,012 pre-schools, both public and private, provide education to 266,793 children aged 0-5[13] in Cambodia.[14] Four early childhood education schemes have been identified, Formal Pre-School, Community Pre-School, Home-based Programs, and Private Pre-School.[15] Early childhood education in Cambodia is regulated by the Ministry of Education, Youth and Sport, which has set the objective to expand this service for children from birth to under 6-year-olds.[16] The significance of

early childhood development has made a strong case for the introduction of preparing children for future development and growth in both online and physical environments.

What Really Is Digital Literacy?

In a digitally and technologically enhanced world, digital skills are deemed to be no longer optional. Over the past decade, terms such as "digital literacy", "digital skills" and " digital competence" were used in overlapping contexts. It began with the term "digital literacy" coined and defined by Paul Gilster as an individual's ability to "understand" and "use" information presented via computers.[17] As with any relatively new concept, the term has evolved to include a wide range of definitions; from rather prescriptive ones that concentrate on what a digitally literate person should be able to do, to others that take a broader perspective and concentrate on what a digitally literate person should be able to achieve.

Richard Lanham claims that "literacy" has a broader semantic reach from "the ability to read and write" to " the ability to understand information however presented."[18] Digital literacy is seen as an umbrella of other terms. Digital literacy includes competences also known as computer literacy, Information Communication and Technology (ICT) literacy, information literacy and media literacy.[19] In DigComp, 5 competence areas outline what the digital competence entails. They are the following: information and data literacy, communication and collaboration, digital content creation, safety, and problem

11. "International Standard Classification of Education (ISCED) | UNESCO UIS," April 23, 2022, 64, https://web.archive.org/web/20220423192159/http://uis.unesco.org/en/topic/international-standard-classification-education-isced.

12. Ibid.

13. Ministry of Education, Youth, and Sport, Cambodia, "National Policy on Early Childhood Care andDevelopment," February 19, 2010, 3, http://www.moeys.gov.kh/index.php/en/policies-and-strategies/399.html.

14. Ministry of Education, Youth, and Sport, Cambodia, "Public Education Statistics and Indicators 2020-2021," 1, accessed November 24, 2021, http://www.moeys.gov.kh/index.php/en/emis/4204.html; Ministry of Education, Youth, and Sport, Cambodia, "Private Education Statistics and Indicators 2020-2021," 1, accessed November 24, 2021, http://www.moeys.gov.kh/index.php/en/emis/4205.html.

15. "Early Childhood Education Department," accessed May 1, 2022, http://www.moeys.gov.kh/index.php/en/ecd/early-childhood-education-department.html.

16. Ministry of Education, Youth, and Sport, Cambodia, "National Policy on Early Childhood Care and Development," 3.

17. Paul Gilster, *Digital Literacy,* 1st edition (New York, NY: John Wiley & Sons, 1998), 1.

18. Lanham A Richard, "Digital Literacy," *Scientific American* 273, no. 3 (1995): 160, https://www.jstor.org/stable/24981653.

19. UNICEF, *Digital Literacy for Children: Exploring Definitions and Frameworks.*

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10. Woolfolk Anita, *Educational Psychology,* 14th Edition (Pearson, 2019), 58, https://www.pearson.com/content/one-dot-com/one-dot-com/us/en/higher-education/program.html.

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solving.[20] With these being said, the term 'digital literacy' will be used for this paper.

Preparing Children for the Future of Digital Identity

In order to stay connected, we have more than one online profile like Facebook, Instagram, LinkedIn, and obviously email. While maintaining multiple online profiles, paper-based identification documents, such as the national ID, drivers license, birth certificate, and educational certificate are still common. Identification is a process to prove a person's identity or existence. Paper-based identifications do not have the advantages when it comes to authentication and protection in a digital infrastructure.[21] Digital identity refers to machine-readable digital data to prove a person's identity.[22] In Australia, the federal government proposed a trusted digital identity system legislation; digital identity makes 80 government services in Australia more accessible in a safe, secure, and convenient manner.[23] With the Digital Economy and Social Policy Framework of Cambodia in place, creating digital citizenship is a priority for Cambodia to achieve digital transformation before 2035.[24] Digital identity

leverages technology to guarantee inclusion, effectiveness, efficiency, and transparency in recognizing a person's identity and providing essential services.[25] Introduction to digital skills in early age enables tremendous opportunities for children through the use of digital technologies at home, for school, and later for work.

The Covid-19 epidemic has, in reality, hastened the digital transition of today's workforce. Automation, robots, and artificial intelligence (AI) have been developed to replace the lost employment, and the technologies will become increasingly vital in meeting demand. According to the McKinsey report, there are four groups of skills that are known as DELTAs. DELTAs is McKinsey's 56 foundational skills for the future of work. An individual with these skills is more likely to be competent, which increases their chances of employment, earnings and work satisfaction. According to the same study, in order to make the 56 foundation skills more explicit, McKinsey compiled a list of 56 'distinct elements of talent' (DELTAs), which was divided into four categories: cognitive, interpersonal, self-leadership, and digital. "We call them DELTAs rather than skills since they are a combination of skills and attitudes." "Adaptability" and "dealing with ambiguity," for example, are attitudes." The research report also found that respondents with higher digital proficiency are more likely to earn higher income.

Estonia is the first country to offer e-Residency, a government-issued digital identity and status that provides access to Estonia's business environment for entrepreneurs from any part of the world to digitally develop and manage an EU-based

company.[26] Digital citizenship eliminates the bureaucracy[27] in legal identification and opens the doors for talents to grow globally. In Cambodia, building digital citizens emphasizes on "promoting digital leadership, developing and mobilizing digital talents and transforming the digital citizens into a driving force for the digital transformation."[28] This clearly implies establishing a strong digital identification system and developing an inclusive approach to digital skill development in children as young as one.

Fostering Digital Literacy for Child Development

Digital literacy is now recognized as the necessary competence of an individual. Digital literacy, known as Digital Competence in European Union context, is part of the Key Competence Framework for Lifelong Learning and interlinked with other competences such as science, technology, engineering, and mathematical; languages, literacy; cultural awareness and expression; entrepreneurship; civic competence; and personal, social and learning to learn.[29] Digital literacy is an enabler to a bottomless container of opportunities and information.

Figure 2: Key Competence Framework for Lifelong Learning

Source: European Commission

20. Riina Vuorikari, Stefano Kluzer, and Yves Punie, "DigComp 2.2: The Digital Competence Framework for Citizens - With New Examples of Knowledge, Skills and Attitudes," JRC Publications Repository, March 17, 2022, 7, https://doi.org/10.2760/115376.

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22. Silvia Masiero and Savita Bailur, "Digital Identity for Development: The Quest for Justice and a Research Agenda," *Information Technology for Development* 27, no. 1 (January 2, 2021): 1–12, https://doi.org/10.1080/02681102.2021.1859669.

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24. Supreme National Economic Council, *Digital Economy and Social Policy Framework of Cambodia 2021-2035,* 2021, 5, https://mef.

gov.kh/download-counter?post=7116.

25. Masiero and Bailur, "Digital Identity for Development," 2.

26. "What Is E-Residency | How to Start an EU Company Online," e-Residency, accessed May 7, 2022, https://www.e-resident.gov.ee/.

27. Ibid.

28. Supreme National Economic Council, *Digital Economy and Social Policy Framework of Cambodia 2021-2035.*

29. Vuorikari, Kluzer, and Punie, "DigComp 2.2," 5.

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Digital skill development should be complemented by building social and emotional skills. Key to promoting child well-being and pro-social development, social-emotional skills also form the foundation for digital citizenship and understanding/engaging in positive digital behaviors. Bolstering both sets of skills can foster inclusion for all children in digital and real world environments.

Dimension	Description
Etiquette	electronic standards of conduct or procedure
Communication	electronic exchange of information
Education	the process of teaching and learning about technology and the use of technology
Access	full electronic participation in society
Commerce	electronic buying and selling of goods 6. Responsibility: electronic responsibility for actions and deeds
Rights	those freedoms extended to everyone in a digital world
Safety	physical well-being in a digital technology world
Security (self-protection)	electronic precautions to guarantee safety

Key Policy Messages

Education systems need to take an inclusive and holistic approach to ensure access for all children and foster the skills that all children need to become active and ethical users of digital technologies. Digital citizenship empowers children to actively and responsibly take part in society. In order to foster the development of digital citizenship, below are the key suggested policies:

- Develop a high-quality technological infrastructure with high connectivity rates.

- Design and incorporate digital literacy and media literacy in the curriculum of early childhood education, not limited to formal early education.

- Develop localized digital content and digital skill training to eliminate language barriers.

- Strengthen teacher training with the integration of digital literacy and digital citizenship to better educate students.

- Engage teachers with new training, co-producing resources and exploring their role in supporting parents.

- Provide outreach programs to enhance understanding of parents and communities on digital literacy.

- Provide support for parents in keeping their children safe online.

- Work with practitioners, communities, and interest groups to develop and disseminate digital literacy.

- Collaborate with relevant actors from development and corporal sectors to build resilience in real world and digital environments.

Conclusion

Early childhood education is a critical stage for children to develop a certain mindset and attitude for their future. Furthermore, it is critical to consider the application of digital skills in early childhood education, particularly for young children's cognitive development, to encourage the early development of digital abilities. Additionally, it is apparent that these skills will better equip children for the future of citizenship. However, with this advancement of digital, automation, and AI technologies, children are increasingly likely to be exposed to a variety of threats. As a result, parents, teachers, and especially schools should be aware of the importance of using technology to educate their children.

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SMART EDUCATION IN SMART CITIES: Is The Cambodian Policy Framework Ready?

VOUCH-IM CHHAY   **SEAKLENG LIM**   **VATANA CHEA**

Introduction

The current pervasive model of education has existed since the 18th century. Originating in Prussia, this education model is characterized as rigid, non-interactive and teacher-centered, and operates under the assumption that students possess the same characteristics and attributes. This rigid and systematic education model reflects the factory model of its contemporary industrial era, which was characterized by mass production, standardization and assembly lines. However, this model continues to exist in the present times. Many educators have criticized the Prussian model as outdated, and that the current education should embed skills that are essential for succeeding in the 21st century.

With the dawn of the fourth industrial revolution, which brings many innovative technologies such as robotics, automation, artificial intelligence and blockchain, it is inevitable that these innovations will also influence the education sector, creating a smart education ecosystem. Smart education has the potential to change the way classrooms operate through personalized, adaptive learning and individualized learning. This new learning style is able to track students' learning ability and adjust the course content according to the student's level of competence which helps ensure the students achieve the desired outcomes.

Even though smart education shows great promise to revolutionize teaching and learning, it is important to understand whether the government's policies are ready to embrace these educational changes, especially for a developing country like Cambodia. The authors argue that despite acknowledging smart education in its policies, the priorities of the Ministry of Education, Youth and Sport currently lie in other areas which are increasing education accessibility, reducing dropouts and ensuring effective leadership and management.
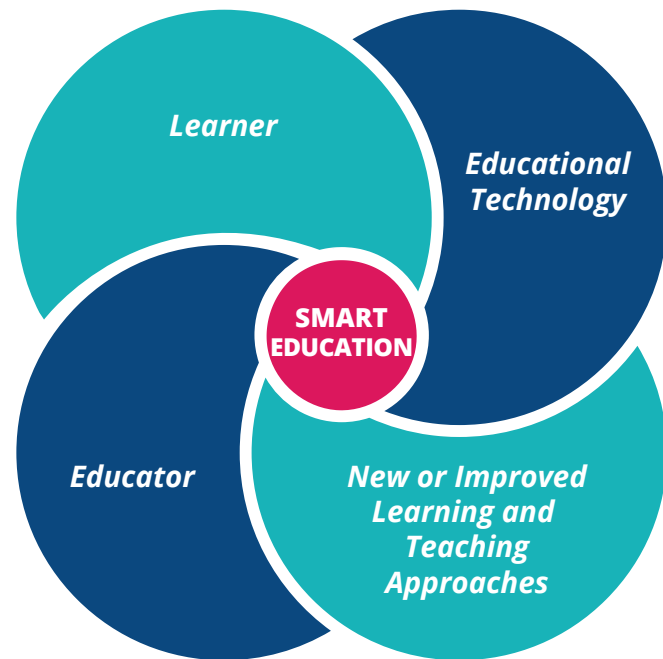
What Is Smart Education?

Smart education is a relatively new concept, yet a number of definitions have been introduced to help with the understanding of this new concept. Smart education could be defined as a contemporary learning environment with technologies to complement the traditional way of teaching and learning. The definition from Zhu and He[1] mentions that smart education is the creation of an intelligent environment by using technologies to facilitate learning, and provide a personalized learning environment and smart pedagogies to develop the talent that is better oriented, of high-quality thinking, and conduct stronger abilities. Demir's[2] framework (Figure 1) highlights four essential elements for smart education. First is the learner who must possess autonomous and collaborative attributes, as well as being technologically literate. Second, are the educators, who must alter their role from directly transferring knowledge to one that facilitates students' learning. Both learner and educator need to be well-versed with information communication technologies, and educators must be able to provide technical support whenever needed by students. Third is educational technology, which are modern technological innovations used in education. However, new educational technology does not necessarily mean it is part of smart education. It has to align with the fourth essential element; the educational technology must also bring with it a new teaching and learning approach.

1. Zhu, Z.T., and B. He. 2012. "Smart education: New frontier of educational informatization." *E-Education Research* 1-13.

2. Demir, Kadir Alpaslan. 2021. "Smart education framework." *Smart Learning Envirnoments.* doi:https://doi.org/10.1186/s40561-021-00170-x.

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Figure 1: Demir's smart education framework

Furthermore, Demir[3] provided a comprehensive list of enabling technologies for smart education, which is used in this paper as a basis for analyzing Cambodia's readiness for smart education.

Table 1: Enabling information technologies for smart education

Information Technology	Definition
Learning Management Systems	Learning management systems is a software application providing teachers the framework that manages all aspects of the student learning process, namely administration, documentation, tracking student progress, and delivering educational courses.
Smart Classrooms	Smart classrooms are physical educational classrooms in which the environments are supported with ICT devices. Smart classrooms may also utilize AI technology.
Virtual classrooms	Virtual classrooms are virtual educational environments in which teachers and students meet using an online platform instead of physically face-to-face.

Information Technology	Definition
Cloud Computing Technology	The technology that enables on-demand access to shared computing resources through the cloud.
Extended Reality (XR)	A term referring to a combination between real and virtual/immersive environments. The latter includes Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR).
Virtual Environments	An immersive computer-generated environment to replace the real one.
Augmented Reality	The technology that employs computer-generated sensory data in real-time and uses them to improve user's sense of the physical world. Pokemon GO mobile app is an example of such technology.
Web 2.0+	Web 2.0+ is a development of Web 1.0. Web 2.0+ technologies offer interactive, semantic, and intelligent web services.
Social Networks	Social networking sites can be defined as the online platforms that allow users to interact.
Educational Resources	Any type of teaching and learning resources including journals, lecture notes, academic presentations, books, sound, video, etc.
Academic and Corporate tubes	Academic or corporate tubes are online video-sharing platforms for academic purposes.
E-books and Interactive Books	E-books and interactive books are digital books enhanced with user interaction ability.
Mobile Technology	A kind of technology that enables portable mobile devices.
Serious Games	Computer games used for instructional purposes.
Learning and Academic Analytics	The collection, measurement, and analysis of data on the student's learning activities. Academic analytics uses business intelligence tools and tactics to reach educational decisions.
Educational Data Mining	Data mining process to obtain data from educational environments to understand student's learning behavior and thereby enhance the quality of education.
Educational Robots	Any type of robot used for educational purposes
Gesture-based Computing	The technology used to understand people's gestures

3. Demir, Kadir Alpaslan. 2021. "Smart education framework." *Smart Learning Envirnoments.* doi:https://doi.org/10.1186/s40561-021-00170-x.

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Information Technology	Definition
Ambient Intelligence	An emerging paradigm that brings intelligence into people's lives with the assistance of intelligent interfaces and smart environments.

Source: Demir (2021).

The Cambodian Policy Framework and Smart Education

The Cambodian government policies included in this study are the National Strategic Development Plan 2019–2023,[4] the Digital Economy and Society Framework 2021–2035,[5] the Education Strategic Plan 2019-2023,[6] Cambodia's Education Roadmap 2030: Sustainable Development – Goal 4,[7] the Policy on Higher Education Vision 2030,[8] and finally, the Cambodia Education Response Plan to the Covid-19 Pandemic.[9] These policies are analyzed in relation to Demir's information technologies listed in Table 3. The result shows that only two out of the six policy frameworks mention information technology components that are applicable in smart education – the Education Strategic Plan 2019 – 2023 (Table 2) and Cambodia's Education Roadmap 2030: Sustainable Development – Goal 4 (Table 3).

Table 2: Smart Education Component in Education Strategic Plan 2019-2023

Education Strategic Plan 2019-2023	
Education resources	Develop the e-learning education system, mobile applications, open educational resources and digital content to promote life-long learning
E-books and interactive books	Develop modern libraries: use of e-books, the internet, and computers

Table 3: Smart Education Component in Cambodia's Education Roadmap 2030: Sustainable Development – Goal 4

Cambodia's Education Roadmap 2030: Sustainable Development – Goal 4	
Smart classrooms	School classrooms in Cambodia will be gradually transformed into smart classrooms that are well equipped with educational and technological resources and provide carefully organized, safe, and conducive learning environments for all. Teachers' roles change to that of facilitators of learning, creating learning opportunities for all through the effective use of a variety of interactive and collaborative instructional methods and pedagogical approaches.
Mobile technology	Promote the use of ICT, mobile technologies in literacy/ numeracy programmes

Despite smart education components appearing in existing policies, only four out of 19 components appeared. Another issue is that the aforementioned policies are primarily focused on other aspects/objectives, with components of smart education only playing a minor role, which also explains why no clear action plans or monitoring and evaluation mechanisms are stated in order to achieve those smart education components.

The question is then, why are there so few mentions of smart education in existing policies, and why is there not yet a policy on smart education? Insights can be found in the Education Strategic Plan 2019-2023, which MoEYS stated to achieve two overarching policies. The first is to guarantee inclusive and equitable quality education and promote lifelong learning opportunities for all, and the second is to ensure effective leadership and management of education officials at all levels. This indicates that much of the effort and resources of MoEYS have been dedicated to ensure accessibility to primary and secondary education as well as to secure high completion rates and reduction of dropout rates, especially at the secondary level.

Conclusion and Recommendations

The smart city is a complex ecosystem made up of the following sectors: smart economics, smart health, smart governance, smart education, and smart transportation. The latter ensures the healthy and successful development of its composite, the smart city, which needs contributions from highly intellectual and innovative individuals, who are in turn a function of smart education and other smart city components. Therefore, smart education and smart cities create a feedback loop that, if appropriately strengthened and maintained, will result in exponential growth and a consequent improvement in the quality of life for local residents.

In recent years, the Royal Government of Cambodia, on many occasions, has emphasized its vision of turning several major urban areas into smart cities. Such emphasis can clearly be seen in some of the government's latest policy frameworks, namely the National Strategic

4. RGC, (Royal Government of Cambodia). 2019. *National Strategic Development Plan 2019-2023.* Royal Government of Cambodia.

5. RGC, (Royal Government of Cambodia). 2021. *Cambodia Digital Economy and Society Policy Framework 2021 - 2035.* Royal Government of Cambodia.

6. MOEYS, (Ministry of Education, Youth and Sport). 2019. *Education Strategic Plan 2019 - 2030.* Ministry of Education, Youth and Sport.

7. MOEYS, (Ministry of Education, Youth and Sport). 2019. *Cambodia's Education 2030 Roadmap: Sustainable Development - Goal 4.* Ministry of Education, Youth and Sport.

8. MOEYS, (Ministry of Education, Youth and Sport). 2014. *Policy on Higher Education Vision 2030.* Ministry of Education, Youth and Sport.

9. MOEYS, (Ministry of Education, Youth and Sport). 2020. *Cambodia Education Response Plan to COVID 19 Pandemic.* Ministry of Education, Youth and Sport.

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Development Plan 2019 – 2023 and the Digital Economy and Society Framework 2021 – 2035. In addition, the Ministry of Education, Youth, and Sport has also attempted to incorporate technologies and their use into the public education system to create a smart learning environment through multiple frameworks including Cambodia's Education 2030 Roadmap and the Education Strategic Plan 2019 – 2023. While these attempts truly deserve a compliment, a question remains unanswered: Do these policy frameworks sufficiently support the development of smart education?

While some components of smart education do exist in the Cambodian government's existing policy framework, specifically the Education Strategic Plan 2019–2023 and Cambodia's Education Roadmap 2030: Sustainable Development – Goal 4, it is still inadequate to support a smart education ecosystem. The priorities of MoEYS currently lie in expanding access to primary and secondary education, ensuring quality education, promoting lifelong learning opportunities, and ensuring effective leadership and management of education officials at all levels.

Regardless, there are steps which can be taken in order to realize the vision of a smart classroom mentioned in Cambodia's Education 2030 Roadmap. First would be the introduction of a charter school based on smart education principles, or ideally to experiment with an existing charter school such as New Generation School (NGS), which is already equipped with modern technology and instructors practicing a new pedagogical approach. Starting this new smart education project will be an expensive endeavor; therefore, various stakeholders should contribute to fund this project. Furthermore, the project should be open to receiving generous donations from foundations and tech companies.

While the project is undergoing its experimental phase, heavy monitoring and evaluation activity must be conducted in order to collect valuable data, especially on what works and what does not. When the government does launch smart education plans on a wider scale, which indeed it must in the future to remain competitive, this data will prove crucial to its successful rollout, as well as in informing the associated policies that will govern smart education.

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LEVERAGING INNOVATIVE TOOLS TO ENGAGE CITIZENS IN BUILDING SMARTER CITIES IN ASEAN AND THE EU

NADINA IACOB

Executive Summary

Digitalisation has been opening novel ways of building smarter and more sustainable cities. In the transformative process of rendering cities smarter, more sustainable, and more resilient, engaging citizens effectively in local policymaking is a key component of mapping issues, crowdsourcing ideas and solutions, and contributing to the effective implementation of smart city initiatives. As cities seek to adapt to changing needs and the challenges of tomorrow, the exchange of best practices between cities can help accelerate the transformative process and better tap existing knowledge and learnings.

Against this background, this paper seeks to investigate the role of citizen participation in smart city strategies in Association of Southeast Asian Nations (ASEAN) and the European Union (EU), with a view to support cooperation and knowledge exchange across regions. Smart city strategies have been key components of the policy agendas of both ASEAN and the EU, and more recently a relevant element of the ASEAN-EU strategic partnership. In addition, in creating smarter cities, the role of citizen participation has been recognised to different extents in the two regions. In this context, the paper takes stock of measures to facilitate how citizens contribute to decision-making in smart cities. The paper relies on an extensive review of literature and policy developments, as well as two case studies deriving insights from examples of citizen participation in local policymaking for smart cities in ASEAN and the EU.

Based on literature review and the case study analysis, this paper outlines several recommendations to boost citizen participation for building smarter cities in the two regions. ASEAN and the EU can support local developments by enhancing cooperation and supporting the exchange of best practices within and between the two regions with respect to creating opportunities for citizen participation in local decision-making and urban development.

Introduction

Cities are home to over half of the global population and are still growing. By 2050 it is expected that over two thirds of the global population will live in cities.[1] Cities also bring massive contributions to the global economic output, with an estimated 80 percent of the global GDP being generated in cities.[2] At the same time, however, urban living is faced with growing challenges. Trends in demographic change (such as urban population growth and aging) bring to the forefront the need for innovative solutions to meet the needs of urban dwellers. Making cities more energy efficient is becoming a key priority in the context of climate change. Moreover, the Sustainable Development Solutions Network (SDSN) estimated that over 65 percent of the Sustainable Development Goals (SDGs) can only be achieved with the sustained engagement of local and regional administrations.[3]

In this context of opportunities and challenges, the concept of smart cities has risen in popularity. The concept of a "smart city", conveying at its core the use of digitalisation and new technologies to address policy issues and improve the

1. United Nations, Department of Economic and Social Affairs, Population Division (2019). World Urbanization Prospects 2018: Highlights. Available at: https://population.un.org/wup/Publications/Files/WUP2018-Highlights.pdf.

2. World Bank (2020). Urban development: overview. Available at: https://www.worldbank.org/en/topic/urbandevelopment/overview#1. Last accessed: 12 November 2021.

3. UN Sustainable Development Solution Network (2016). Getting Started with the SDGs in Cities. A Guide for Stakeholders. Available at: http://unsdsn.org/wp-content/uploads/2016/07/9.1.8.-Cities-SDG-Guide.pdf. Last accessed: 12 November 2021.

competitiveness of cities, has become an approach for shaping cities to better address the needs of citizens and evolving challenges across three major areas: economic, social, and environmental.[4] From the economic perspective, the deployment of new technologies for smart cities is expected to enhance the competitiveness of cities and drive growth. From a social perspective, smart cities put an emphasis on citizen well-being, improving the design and delivery of public services and better responding to the fundamental needs of citizens. Finally, and especially important in the context of sustainable development, the environmental dimension brings to the need to reduce the impact of cities on the environment and improve energy efficiency, especially in the context in which it is estimated that cities emit over 70 percent of the total greenhouse emissions.[5]

Most recently, the COVID-19 pandemic has revealed some of the weaknesses of cities. The high level of interconnected activities and population density that creates opportunities and growth can also make cities vulnerable in the face of global crises - such as a pandemic. Shaping the cities of tomorrow to better respond to future challenges is paramount.[6] In the process of making cities smarter and more sustainable, stakeholder cooperation is essential and citizens are at the centre.

Citizens are both the ultimate beneficiaries of measures to make cities smarter and more sustainable, as well as key active stakeholders to provide the necessary

input for such measures, and to shape the smarter cities of tomorrow. As smart cities look to innovation and digitalisation to tackle policy challenges, one key question is how digital tools can be leveraged for citizen participation in smarter cities. Against this background, this article investigates how the role of citizens in building smart cities is considered in the policy process. The article focuses on two regions – namely ASEAN and the EU - and their approach to citizen participation for smart cities. In addition, the article analyses two concrete measures aimed at facilitating citizen participation for local policy making, putting the emphasis on the need for identifying and exchanging best practices between cities.

The choice of regions is rooted in the evolving and strengthening partnership between ASEAN and the EU, as well as in the prominence of the smart city concept in the policy strategies of the two regions. The paper relies on an extensive review of the literature on smart cities and citizen participation, an overview of the key policy developments related to smart cities and citizen participation in ASEAN and the EU over the last decade, and on two case studies of innovative methods for citizen participation in cities in ASEAN and the EU, namely Singapore and Madrid.

The case studies are based on publicly available information of the two initiatives, as discussed more in detail in section 4. The smart city is a complex ecosystem made up of the following sectors: smart economics, smart health, smart governance, smart education, and smart transportation. The latter ensures the healthy and successful development of its composite, the smart city, which needs contributions from highly intellectual and innovative individuals, who are in turn a function of smart education and other smart city components. Therefore,

smart education and smart cities create a feedback loop that, if appropriately strengthened and maintained, will result in exponential growth and consequent improvements in the quality of life for local residents.

The paper is structured as follows:

1. The article first presents the latest literature on smart cities and outlines the role of citizen participation in policymaking for smart cities.

2. It then discusses the policy context around smart cities in ASEAN and the EU and the extent to which citizen participation is emphasised in these regions.

3. Based on a review of the different forms of citizen participation, the article then discusses selected case studies of innovative methods to facilitate citizen participation for smarter cities in ASEAN and the EU.

4. Finally, the article concludes with recommendations for designing innovative, digitally driven approaches to citizen participation for smart cities.

Leveraging Citizen Participation in the Policymaking Process

Citizens as Key Stakeholders in Smart Cities

Various definitions of smart cities have been proposed.[7] A comprehensive definition has

been put forward by the United Nations Economic Commission for Europe (UNECE) and International Telecommunication Union (ITU), developed based on input from over 300 experts. The UNECE and ITU thus define the smart, sustainable city as " an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects."[8] Furthermore, the Organisation for Economic Cooperation and Development (OECD) emphasises the importance of collaboration and stakeholder engagement in the implementation of smart cities initiatives.[9] The need to successfully involve stakeholders emphasises the cross-cutting nature of the difficulties that cities face, as well as the necessity to find comprehensive solutions incorporating the public and corporate sectors, as well as civil society.

As complex systems, smart cities include several core components. Three main components are evoked in the literature (Pardo and Nam (2011)[10], Meijer and Bolivar (2015)[11]): technology (i.e. infrastructure and

4. OECD (2020). Smart Cities and Inclusive Growth: Building on the Outcomes of the 1st OECD Roundtable on Smart Cities and Inclusive Growth. Available at: https://www.oecd.org/cfe/cities/OECD_Policy_Paper_Smart_Cities_and_Inclusive_Growth.pdf. Last accessed: 12 November 2021.

5. Ibid.

6. Sharifi, A., & Khavarian-Garmsir, A. R. (2020). The COVID-19 pandemic: Impacts on cities and major lessons for urban planning, design, and management. The Science of the total environment, 749, 142391. https://doi.org/10.1016/j.scitotenv.2020.142391.

7. Ramaprasad A., Sánchez-Ortiz A., Syn T. (2017). A Unified Definition of a Smart City. In: Janssen M. et al. (eds) Electronic Government. EGOV 2017. *Lecture Notes in Computer Science,* 10428. Springer, Cham. https://doi.org/10.1007/978-3-319-64677-0_2. Last accessed: 12 November 2021.

8. United Nations, Economic and Social Council (2015). The UNECE–ITU Smart Sustainable Cities Indicators. https://unece.org/fileadmin/DAM/hlm/projects/SMART_CITIES/ECE_HBP_2015_4.pdf. Last accessed: 12 November.2021; ITU-T Recommendation Y.4900.

9. OECD (2019). Enhancing The Contribution of Digitalisation to The Smart Cities of The Future. Available at: https://www.oecd.org/cfe/regionaldevelopment/Smart-Cities-FINAL.pdf. Last accessed: 12 November 2021.

10. Nam, T., & Pardo, T.A. (2011). Conceptualizing smart city with dimensions of technology, people, and institutions. *dg.o '11:* Proceedings of the 12th Annual International Digital Government Research Conference: Digital Government Innovation in Challenging Times, June 2011 pp. 282–291. https://doi.org/10.1145/2037556.2037602

11. Meijer, A., & Bolívar, M. P. R. (2016). Governing the smart city: a review of the literature on smart urban governance. International Review of Administrative Sciences, 82(2), 392–408. https://doi.org/10.1177/0020852314564308

enabling technologies), institutional factors (namely governance, interaction between stakeholders, and policy framework), and human factors (education and skills). Attempts to operationalise the concept of smart cities further define six characteristics and factors of smart cities, pointing to the key outcomes that are expected from the implementation of smart city initiatives: smart economy, smart people, smart governance, smart mobility, smart environment, smart living.[12] Smart city initiatives rely on stakeholders, including citizens, to collaborate and contribute to the development and implementation of initiatives to improve the design and functioning of cities. Indeed, the need for citizen participation to support smart city initiatives is increasingly emphasised in the literature.[13,14,15]

Approaches to Citizen Participation: Transparency to Co-creation

Citizens can be engaged in the design and implementation of smart city initiatives at different levels of the process (from passive engagement, for instance in the form of information provision from public administrations to active involvement based on co-creation) as well as through

different tools (from petitions to participatory budgets). Increasingly, co-creating policies with stakeholders and citizens in particular is seen as a necessary step to drive innovation and effectively respond to citizens' needs.[16]

An extensive study of 173 cities in Europe[17] identifies four levels of citizen participation in shaping policies at the local level, going from the passive level (information) to increasingly active levels of participation and co-creation (consultation, co-design and co-decision).[18] In addition, the tools that can be used to facilitate and stimulate citizen participation range from more traditional tools such as petitions to more innovative tools such as participatory budgets and social labs.

In the context of smart cities, which are crucially underpinned by the promise of digitalisation and new technologies, there is an increasing focus on the use of digital tools to promote citizen participation and engagement. Digitally enabled citizen participation is expected to actively contribute to the development of not only smart but also human-centric cities.[19]

Digital tools can be used to enhance both passive and active forms of citizen engagement. When it comes to passive

engagement of citizens, the potential of digital tools and technologies lies primarily in the management of big data and the visualisation and communication of information derived from the processing of big data.[20] Big data provides the basis for city authorities to take more evidence-based decisions. At the same time, digital technologies can also help distil information from big data and improve citizens' access to information about developments in different sectors of their city. In terms of the active engagement of citizens, digital tools in the form of web tools and mobile apps can enable the citizens' participation at different stages of the policymaking process. Such tools can provide a channel for citizens to raise issues, participate in online surveys, and provide feedback to authorities. Crowdsourcing and co-design digital tools can enable greater participation through collection of ideas and the design and implementation of new policies. Finally, e-platforms can be used as a comprehensive approach to citizen participation, combining multiple tools and opportunities for participation.[21]

While promising, digital technologies have, nevertheless, limitations. In deploying such tools, stakeholders (whether policymakers, civil society, or academia in particular) must consider any impacts on inclusion deriving from digital divides and limited access to the Internet. This may be a larger issue in ASEAN compared to the EU. The Internet penetration rate in ASEAN stands at approximately 58 percent[22] whereas in the

EU the rate stands at 90 percent.[23] Beyond the average rates, disparities within the countries of the two regions also exist. It is not only the overall access to the internet that is relevant, but also the devices that are predominantly used. In this respect, ASEAN has a high rate of mobile connectivity (141 percent[24] compared to approximately 121 percent in the EU[25]), which indicates that for broader participation, digital solutions that are adapted to mobile users would be relevant for the effective deployment of digital participation solutions.

ASEAN and EU Policy Perspectives on Smart Cities and Citizen Participation

In the context of current policy trends and challenges in urban areas, smart cities hold strategic positions in the policy agendas in ASEAN and in the EU. While not a panacea, smart cities have the ability to address some of the most pressing concerns confronting metropolitan regions, such as demographic trends, climate change, and the need to manage resources more efficiently, while also contributing to the ultimate objective of enhancing inhabitants' living conditions.

Strengthening Cooperation for Smart ASEAN Cities

The strategic role of smart cities in ASEAN is embodied by the ASEAN Smart Cities

12. Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanovic, N., & Meijers, E. (2007). Smart Cities - Ranking of European medium-sized cities. Vienna University of Technology. Available at: https://curis.ku.dk/ws/files/37640170/smart_cities_final_report.pdf

13. Bull, R. and Azennoud, M. (2016). Smart citizens for smart cities: participating in the future. *Proceedings of the Institution of Civil Engineers - Energy,* 169 (3), pp. 93-101. https://doi.org/10.1680/jener.15.00030

14. Bouzguenda, I.,Alalouch, C., Fava, N. (2019). Towards smart sustainable cities: A review of the role digital citizen participation could play in advancing social sustainability. Sustainable Cities and Society, Vol. 50, https://doi.org/10.1016/j.scs.2019.101627.

15. Oliveira, Á., Campolargo, M. (2015). From Smart Cities to Human Smart Cities. *2015 48th Hawaii International Conference on System Sciences,* pp. 2336-2344, doi: 10.1109/HICSS.2015.281.

16. Voorberg, W.H., Bekkers, V.J.J.M., Tummers, L.G. (2015). A systematic review of co-creation and co-production: Embarking on the social innovation journey. Public Management Review, volume 17, issue 9, pp. 1333 - 1357, http://dspace.library.uu.nl/handle/1874/334352.

17. EUROCITIES (2021). City administrations paving the way to participatory democracy. Available at: https://eurocities.eu/wp-content/uploads/2021/10/Cities-and-participation_Eurocities_Brief.pdf. Last accessed: 12 November 2021.

18. Similar classifications of the different levels of citizen engagement, going from passive to active engagement, are discussed in the literature. For instance: Hasler, S., Chenal, J., & Soutter, M. (2017). Digital tools and citizen participation: Towards sustainable and responsive urban planning. *UPPD 2017 Conference Proceedings,* doi: 10.5176/2425-0112_UPPD17.18.

19. Ibid.14

20. Stratigea, A., Papadopoulou, C.A., Panagiotopoulou, M. (2015). Tools and Technologies for Planning the Development of Smart Cities. *Journal of Urban Technology,* 22:2, 43-62, doi: 10.1080/10630732.2015.1018725

21. Ibid.

22. Centre for Liveable Cities Singapore (2018). ASEAN Smart Cities Network. Available at: https://www.clc.gov.sg/docs/default-source/books/book-asean-smart-cities-network.pdf.

23. Eurostat (2020). Digital economy and society statistics - households and individuals, Internet access of households 2014 and 2019. Available at: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Digital_economy_and_society_statistics_-_households_and_individuals

24. Ibid.22

25. World Bank (2021). Mobile cellular subscriptions (per 100 people) - European Union 2020, International Telecommunication Union (ITU) World Telecommunication/ICT Indicators Database. Available at: https://data.worldbank.org/indicator/IT.CEL.SETS.P2?locations=EU

Network (ASCN).[26] In an initiative led by Singapore, an often-cited example of a smart city,[27] the network aims to foster cooperation in the region, facilitate the exchange of best practices, promote partnerships between stakeholders as well as secure support from partners beyond ASEAN. At the level of concrete implementation, the ASCN will monitor the progress of smart city initiatives in 26 pilot cities in ASEAN.[28] The work of the ASCN is aligned with a key initiative of the Master Plan on ASEAN Connectivity 2025 in promoting sustainable urbanisation.[29] Such initiatives come in the wider context of massive urbanisation in the region, with the proportion of the urban population in ASEAN expected to increase to 65 percent in 2050 (compared to 47 percent in 2014) and five ASEAN nations expected to become countries with a majority urban population.[30] Furthermore, the environmental sustainability aspect of urbanisation is particularly emphasised through related actions, such as the ASEAN Cooperation on Environmentally Sustainable Cities, established already in 2005.[31]

The ASCN endorsed in 2018 the ASEAN Smart Cities Framework, a comprehensive document providing the basis for the ASCN activities and, importantly, emphasising key objectives and areas of focus for the development of smart cities in ASEAN. The framework emphasises three interdependent objectives relating to the economic, social and environmental aspects of smart cities, namely competitive economy, sustainable environment, and high quality of life, as well as six developmental focus areas, including civic and social, health and well-being, safety and security, quality environment, infrastructure, also industry and innovation.[32] From the point of view of stakeholder engagement, the ASCN puts an emphasis on collaboration and partnerships to engage the public and private sector, as well civil society, multilateral financial organisations and international organisations in the shaping of smart cities. The importance of citizen centricity in designing smart cities is recognised, especially through specific initiatives, such as the Smart City Thailand initiative.[33]

Tapping the Opportunities of the Digital Transformation for Smart Cities in the EU

In the EU, smart city initiatives are closely intertwined with digital transition strategies, research, and innovation, as well as regional policies. The stronger economic and political cooperation and coordination in the EU translates into a mix of tools that can be deployed in support of smart city initiatives, including strategic projects devised at the EU level but also EU funds.

Several recent initiatives are relevant. The European Innovation Partnership on Smart Cities and Communities (EIP SCC)[34], established in 2012, put stakeholder engagement at the centre, bringing together cities, industry, civil society, and other smart city actors in the EU to develop smart city solutions in three areas: ICT, energy, and transport. The Partnership evolved into the Smart Cities Marketplace, building also on a series of other EU-supported projects for smart cities (the EU Smart Cities Information System[35]). The Marketplace is a multipurpose platform facilitating stakeholder collaboration through events, community building, and, importantly, providing a space of bankable smart city projects to be paired with investors. The Marketplace includes six action clusters that support the identification of problems and the sharing of best practices on particular issues.[36] One of the action clusters ("Citizen Focus") acknowledges the role of not only facilitating citizen participation but encouraging co-creation across the different smart city areas as well as planning and implementation.[37] The Urban Agenda for the EU, set up in 2016[38], also supports collaboration among stakeholders to develop solutions for smart cities. With several partnerships set up on a variety of topics including circular economy, digital transition, and housing among others,

the Urban Agenda puts the emphasis on both smart and sustainable growth.[39] As the monitoring of progress is crucial, one of the actions of the digital transition partnership relates to the development of a Digital Economy and Society Index (DESI) at the local level.[40]

Finally, there are also noteworthy steps coming directly from cities and calling for close cooperation: the "Living-in.EU" movement and the "Declaration on Citizens' Engagement". Public authorities at the local, regional, national and the EU levels committed to, among others, strengthening investment, facilitating the development of digital solutions for cities, and increasing the focus on citizen centricity in policy design in the "Declaration on joining forces to boost sustainable digital transformation in cities and communities in the EU"[41] as part of the "Living-in.EU" movement. This step comes to compliment the EU's approach to boosting smart cities and tapping the potential of the digital transformation. In addition, almost 80 European cities adopted the "Declaration on Citizens' Engagement" putting forward a clear call for involving citizens in the design and implementation of smart cities.[42]

EU-ASEAN Cooperation on Smart Cities

Both ASEAN and the EU place a great emphasis on the role of cooperation and the exchange of best practices to achieve smart

26. The ASCN was established in 2018. See: https://asean.org/chairmans-statement-of-the-32nd-asean-summit/

27. See for instance the smart city index developed by the International Institute for Management Development (IMD): IMD (2021). Smart City Index 2021. Available at: https://www.imd.org/smart-city-observatory/home/#_smartCity. Last accessed: 12 November 2021.

28. ASEAN (2019). ASCN2019 - ASEAN Smart Cities Network: Advancing Partnership for Sustainability. Available at: https://asean.org/wp-content/uploads/2021/08/ASCN2019-Report.pdf. Last accessed: 12 November 2021.

29. ASEAN (2016). Master Plan on ASEAN Connectivity 2025. Available at: https://asean.org/wp-content/uploads/2021/08/8_compressed.pdf. Last accessed: 12 November 2021.

30. UN Environment (2018). Sustainable Urban Infrastructure Transitions in the ASEAN Region: A Resource Perspective. United Nations Environment Programme. Available at: https://wedocs.unep.org/handle/20.500.11822/31582. Last accessed: 12 November 2021.

31. ASEAN Cooperation on Environmentally Sustainable City, https://environment.asean.org/awgesc/. Last accessed: 12 November 2021.

32. ASEAN Smart Cities Framework, Endorsed by ASCN on 8 July 2018. Available at: https://asean.org/wp-content/uploads/2021/09/ASEAN-Smart-Cities-Framework.pdf. Last accessed: 12 November 2021.

33. ASEAN (2019). ASCN2019 - ASEAN Smart Cities Network: Advancing Partnership for Sustainability, p. 63. Available at: https://asean.org/wp-content/uploads/2021/08/ASCN2019-Report.pdf. Last accessed: 12 November 2021.

34. European Commission (2012). Communication on Smart Cities and Communities - European Innovation Partnership, C(2012)4701. Available at: https://ec.europa.eu/transparency/documents-register/detail?ref=C(2012)4701&lang=en.

35. https://www.ceps.eu/ceps-projects/eu-smart-cities-information-system-scis/

36. European Commission, Smart Cities Marketplace: Action Clusters, https://smart-cities-marketplace.ec.europa.eu/action-clusters-and-initiatives/action-clusters. Last accessed: 12 November 2021.

37. European Commission, Smart Cities Marketplace: Action Clusters, Citizen focus, https://smart-cities-marketplace.ec.europa.eu/action-clusters-and-initiatives/action-clusters/citizen-focus. Last accessed: 12 November 2021.

38. Urban Agenda for the EU: 'Pact of Amsterdam', Agreed at the Informal Meeting of EU Ministers Responsible for Urban Matters on 30 May 2016 in Amsterdam, The Netherlands, https://ec.europa.eu/futurium/en/system/files/ged/pact-of-amsterdam_en.pdf. Last accessed: 12 November 2021.

39. European Commission, The Urban Agenda for the EU, https://ec.europa.eu/regional_policy/en/policy/themes/urban-development/agenda/. Last accessed: 12 November 2021.

40. See Action 5 of the Partnership Action Plan: https://futurium.ec.europa.eu/en/urban-agenda/digital-transition/action-plan/digital-transition-action-plan. Last accessed: 12 November 2021.

41. See: Declaration on joining forces to boost sustainable digital transformation in cities and communities in the EU, https://living-in.eu/declaration. Last accessed: 12 November 2021.

42. EUROCITIES, 'There is no Europe without citizens,' https://citizens.eurocities.eu/. Last accessed: 12 November 2021.

city goals. The strategic partnership between the two regions delivers specific actions in this sense. The EU committed to contributing 5.1 million EUR to the Smart Green ASEAN Cities Programme between 2021 and 2025.[43] The programme aims to contribute to the ongoing initiatives in the region (the ASCN, the ASEAN Sustainable Urbanisation Strategy, as well as the ASEAN Initiative on Environmentally Sustainable Cities) with a focus on reducing the environmental impact of urban areas.

Case Studies on Citizen Participation for Smart Cities

Building on the key aspects of citizen participation in the digital age and the relevance of smart city policies in ASEAN and the EU, two case studies of citizen participation at the city level are discussed: the redesigning of Singapore's Tanjong Pagar neighbourhood and Madrid's platform for digital citizen participation, Decide Madrid. Smart cities draw on the opportunities brought by ICT and innovation; the two case studies underline how, in the context of smart cities, digital tools can be deployed to engage citizens in shaping local policies. The case studies explore the background and objectives of the two initiatives for citizen participation, as well as the approach used, analysing them based on the following criteria:

- Effectiveness, detailing the extent to which the initiative has reached its objectives;

- Accessibility and inclusion, referring to the way in which the tools are made available to citizens and the extent to which issues such as digital divide are considered; and

- Reusability, capturing the extent to which the tools can be applied in different cases and by different cities.

These criteria would shed light on key experiences from the interventions, as well as outline how they may be reused and reapplied in the future to stimulate citizen participation.

Redesigning Neighbourhoods: The Case of "Ideas for Tanjong Pagar"

Background and Objectives

Research experiments play a key role in showcasing how new tools can be used to facilitate citizen participation. At the same time, they show that researchers can play a crucial role as initiators of citizen participation projects and partners for policymakers. These key aspects are reflected in the case of crowdsourcing ideas and feedback from citizens for the redesign of the Tanjong Pagar district in Singapore.

"Ideas for Tanjong Pagar" was a project implemented in 2018 by the research centre Future Cities Laboratory (FCL) of the ETH-Singapore in cooperation with the NGO for community engagement Participate in Design.[44] The project aimed to showcase an innovative tool for citizen participation in urban planning. While the project was not initiated by policymakers, but by researchers, it was launched in the context in which the Urban Planning Authority of Singapore announced plans for the urban development of the "Greater Southern Waterfront", an area covering among others the Tanjong Pagar

district.[45] The redevelopment of Tanjong Pagar is planned to begin after 2027.[46] In this context, the objectives of the "Ideas for Tanjong Pagar" project were two-fold: to test a new tool for citizen engagement and to contribute, through the new tool, to ongoing policy developments.

Approach

The approach adopted in the project consisted in an interactive map-based design tool. The wider public was invited to participate in the design exercise and share their ideas in an intuitive way, by drawing on the map their vision of urban development for Tanjong Pagar. The design exercise was accompanied by survey questions to understand the rationale behind the design choices made by respondents. One of the software solutions used to gather input from the public was Maptionnaire,[47] a community engagement platform specialised in map-based tools for citizen participation and data collection.[48] An additional software solution, based on an interactive map, was also developed by FCL.[49]

Analysis

From the point of view of **effectiveness,** it is important to understand how the project achieved its objectives of testing a new tool and contributing to policy discussions. The project reached overall positive results by testing the map-based tool to stimulate the public to provide ideas in an intuitive way. The experience during the project showed that the approach was positively received by the public.[50] In particular, the Maptionnaire tool appeared to be effective in engaging people to contribute ideas.[51] Depending on the interface of the tool and the specific tasks the public is asked to complete, additional support (for instance by organising in-person events to accompany the online process) for respondents may enhance effectiveness.[52]

The objective of providing input for the future urban development plans for Tanjong Pagar were only partially reached. On the one hand, the approach is promising in terms of stimulating citizen participation, as shown by the overall positive feedback from the users of the tool. On the other hand, the overall participation rate remained limited. Several factors may have affected participation. First, the project was run by a research institute and an NGO, without a direct link to policymakers. This may have had an impact on how citizens perceived the usefulness of participating in the project. Second, the redevelopment of the Tanjong

43. European External Action Service, Factsheets: Smart Green ASEAN Cities Programme, https://eeas.europa.eu/sites/default/files/factsheet_sgac.pdf. Last accessed: 12 November 2021.

44. The website of the project is only available in an archived version, available at: http://web.archive.org/web/20210513142804/https://ideasfortanjongpagar.com/about-the-study/. Last consulted: 7 December 2021.

45. Urban Planning Authority Singapore (2021). Urban Transformations, Greater Southern Waterfront: Gateway to Future Live, Work & Play. Available at: https://www.ura.gov.sg/Corporate/Planning/Master-Plan/Urban-Transformations/Greater-Southern-Waterfront. Last consulted: 7 December 2021.

46. URA (2020). Speech by Mr Lawrence Wong, Minister for National Development and Second Minister for Finance, at the Launch of Exhibition of Public Ideas for Pasir Panjang Power District. Available at: https://www.ura.gov.sg/Corporate/Media-Room/Speeches/speech20-03

47. Maptionnaire, available online at: https://maptionnaire.com/. Last accessed: 7 December 2021.

48. The web app developed for this project using Maptionnaire is available at: https://app.maptionnaire.com/en/3131/. Last accessed: 7 December 2021.

49. Müller, J. (n.a.). Quick Urban Analysis Kit. Available at: https://johannesmueller.org/slideshow/quakit.html. Last accessed: 7 December 2021.

50. Müller, J., Asada, S., & Tomarchio, L. (2020). Engaging the Crowd: Lessons for Outreach and Tool Design from a Creative Online Participatory Study. *International Journal of E-Planning Research (IJEPR), 9(2),* 66-79, p. 75. https://doi.org/10.3929/ethz-b-000400521

51. Maptionnaire (2018). Singapore-ETH Future Cities Laboratory Designs New Waterfront Neighborhood with Citizens. Available at: https://maptionnaire.com/best-participation-practices/people-centric-participation-tool. Last accessed: 7 December 2021.

52. Müller, J., Asada, S., & Tomarchio, L. (2020). Engaging the Crowd: Lessons for Outreach and Tool Design from a Creative Online Participatory Study. *International Journal of E-Planning Research (IJEPR), 9(2),* 66-79, p. 75. https://doi.org/10.3929/ethz-b-000400521

Pagar district is planned to begin after 2027. Hence, the distance in time between the implementation of the project and the expected implementation of redevelopment plans is relatively long and might have influenced the desire of citizens to engage early in the process.

In terms of **accessibility and inclusion,** the project emphasised the need for user-friendliness in the development of the tool. In particular, feedback collected from respondents also helped improve the approach taken in the development and implementation of the map-based tool of the FCL,[53] by focusing on providing more concise information and an intuitive interface that anticipates the needs of respondents. A concrete example of the need for increased accessibility emerged during the project. The tool was promoted through different channels, including on social media, a channel that is often accessed via mobile devices. As the tool was not optimised for mobile devices, accessibility was an issue from this point of view.[54] In addition to the tool developed by FCL, the Maptionnaire tool was found to have an intuitive interface, with features that were familiar to respondents and thus easy to use.[55]

Finally, while user-friendliness is essential, inclusion needs to be considered in the context of the digital divide. Indeed, the

project also highlighted that in-person events and assistance may be useful to generate greater participation.[56]

In terms of **reusability and scalability,** the approach can be deployed in other situations to support citizen-centric urban development. For instance, the tool developed by FCL was applied to develop an exercise in collaboration with the Singapore Urban Authority, with the aim to gather input from citizens for the remodelling of a former air base.[57] The Maptionnaire tool already includes several reuse examples in cities including Stockholm, Denver, and Edinburgh, among others.[58] The tools, however, are not open source. The level of reusability thus depends on the extent to which the FCL-developed tool is maintained by the research centre and made available more widely. In the case of Maptionnaire, using the tool implies relying on the services offered by the platform.

Proposing, Debating, Voting as E-participation: The Case of "Decide Madrid"

Background and Objectives

Launched in September 2015, "Decide Madrid" is an e-participation platform allowing citizens to become involved at different levels of the decision making process at the local level. The objective of the initiative, as described on the platform, is to encourage citizen participation and

particularly "the generation of new and viable ideas and proposals for improving their quality of life", thus contributing to "better decisions taken for the general interests".[59]

The platform was launched by the City Council of Madrid and it relies on the open source e-participation web software "Consul". Originally developed for Madrid, the software is now used around the world by 135 institutions in 35 countries.[60] The City Council of Madrid also offers assistance to any other institutions who are interested in reusing the software.[61]

Approach

Decide Madrid is a comprehensive platform that offers several tools for citizen participation: citizens can make proposals, vote on proposals (proposals made by citizens who receive enough support) or on issues on which the municipality wants the opinion of citizens, decide on how to allocate specific shares of the budget (participatory budget), participate in the development or modification of local regulations, and engage in discussions and debates.[62] For the participatory budget procedure for 2021, €35 million of the budget is available for projects proposed at the district level and an additional €15 million is available for projects proposed at the municipal level or that cover multiple districts.[63] Overall, the sum represents approximately 0.9 percent of the

2021 municipal budget, marking a decrease compared to previous years (for instance, in 2019, the share of the municipal budget reserved for the participatory budget process was approximately 1.7 percent[64]).

The platform can be used by different stakeholder groups, but access to certain features is restricted to the extent to which users verify their identity and prove their status as residents of Madrid. For instance, to vote on proposals, users need to be residents of the city and over 16 years old.[65]

Analysis

In terms of the **effectiveness** of the approach, several key performance indicators can provide insights into how Decide Madrid has been reaching its objectives. For instance, over 26,000 proposals have been submitted since the launch of the platform. However, only two proposals received enough support from other citizens in order to submit them to a vote. Together with other issues submitted to vote by the City Council, in total 35 voting procedures have been launched using the platform. Further figures are described in Table 1.

A study published in 2020 showed that while the number of registered proposals as well as the number of projects for the participatory budget decreased until 2018, participation increased in different areas.[66] For instance, the number of citizens taking part in the participatory budget process increased from 45,529 in 2016 to 91,032 in 2018 and this

53. Müller, J., Asada, S., & Tomarchio, L. (2020). Engaging the Crowd: Lessons for Outreach and Tool Design from a Creative Online Participatory Study. *International Journal of E-Planning Research (IJEPR), 9(2),* 66-79. https://doi.org/10.3929/ethz-b-000400521

54. Müller, J., Asada, S., & Tomarchio, L. (2020). Engaging the Crowd: Lessons for Outreach and Tool Design from a Creative Online Participatory Study. *International Journal of E-Planning Research (IJEPR), 9(2),* 66-79, p. 71. https://doi.org/10.3929/ethz-b-000400521

55. Maptionnaire (2018). Singapore-ETH Future Cities Laboratory Designs New Waterfront Neighborhood with Citizens. Available at: https://maptionnaire.com/best-participation-practices/people-centric-participation-tool. Last accessed: 7 December 2021.

56. Müller, J., Asada, S., & Tomarchio, L. (2020). Engaging the Crowd: Lessons for Outreach and Tool Design from a Creative Online Participatory Study. *International Journal of E-Planning Research (IJEPR), 9(2),* 66-79, p. 75. https://doi.org/10.3929/ethz-b-000400521

57. Müller, J. (n.a.). Quick Urban Analysis Kit. Available at: https://johannesmueller.org/slideshow/quakit.html. Last accessed: 7 December 2021.

58. Maptionnaire, Where Maptionnaire works. Available at: https://maptionnaire.com/#use-cases. Last accessed: 7 December 2021.

59. Decide Madrid. Condiciones de uso. Available at: https://decide.madrid.es/condiciones-de-uso. Last accessed: 7 December 2021.

60. According to the statistics recorded on the website dedicated to the Consul project on 7 December 2021. See: https://consulproject.org/en/#features

61. Decide Madrid. Utilízalo en tu municipio. Available at: https://decide.madrid.es/mas-informacion/como-usar. Last accessed: 7 December 2021.

62. Decide Madrid. Ayuda. https://decide.madrid.es/mas-informacion. Last accessed: 7 December 2021.

63. Decide Madrid. Presupuestos Participativos 2021. Available at: https://decide.madrid.es/presupuestos. Last accessed: 7 December 2021.

64. City of Madrid Open Budgets. Revenue and Expenditure at City of Madrid 2019. Available at: https://presupuestosabiertos.madrid.es/en/resumen#year=2019. Last accessed: 7 December 2021.

65. https://decide.madrid.es/vota. Last accessed: 7 December 2021.

66. Royo, S., Pina, V. and Garcia-Rayado, J. (2020). Decide Madrid: A Critical Analysis of an Award-Winning e-Participation Initiative. Sustainability 12, no. 4: 1674. https://doi.org/10.3390/su12041674

trend was also reflected in an increase in the votes cast on the projects to be selected for the participatory budgets (from 32,725 votes in 2016 to 53,891 votes in 2018 in the final phase). However, a slight decrease was registered in 2019 (see Table 1).This indicates a considerably higher attraction of the participatory budget element, which may be attributed to a closer connection between how citizen participation translates into actual actions performed by the local government. Information is also available on the platform concerning the evolution of approved projects. Nevertheless, a study suggests that more information and follow-up about the progress of projects and the link to the contributions of citizens would be useful to increase the effectiveness of the platform.[67]

Table 1: Summary of key performance indicators for the tools deployed on the Decide Madrid e-participation platform

Tool	Key Performance Indicator	Value
Proposals	Total number of proposals submitted	26,601
	Proposals that received enough support to be submitted to vote	2
Voting	Number of issues submitted to vote at the municipal level	13
	Number of issues submitted to vote at the district level	22
Participatory budget (2019)*	Number of projects proposed	4,426
	Number of projects selected in the final phase	693
	Number of projects selected for implementation	41
	Number of citizens who participated in the process	75,608
	Number of votes cast in the final phase	44,149
Development or modification of local regulations	Number of regulatory issues on which input from citizens was sought	117
Debates and discussions	Number of items open for debates and discussions	3,776

Note: The values collected for the performance indicators capture the activity on the Decide Madrid platform from when it was initiated in 2015 up to 9 December 2021.

Note*: The key performance indicators and values for the participatory budget related to the 2019 exercise. The total budget available for the year for this exercise was €100 million (€30 million for city-wide projects and €70 million for district-level projects).

Source: Data retrieved from the Decide Madrid platform on 9 December 2021.

While Decide Madrid proposes a comprehensive digital approach to enhancing citizen participation, it is also important to note that steps were taken to ensure **accessibility and inclusion** to participatory processes offline. Key participation options available on the platform (making proposals, voting, getting involved in the participatory budget process) are also available offline, in-person, by visiting one of the 26 Citizen Assistance Offices ("Oficinas de Atención al Ciudadano").[68] In terms of the demographics of online participation, the distribution by age shows that multiple age groups were engaged on the platform. For instance, when it comes to the participatory budget process for 2019, the greatest level of participation was among citizens between 30 and 44, but it is noteworthy that older citizens are also engaged in the process.[69] Concerns about digital divide are therefore more limited, especially when considering the possibilities for offline participation.

In terms of **reusability,** the underlying software, Consul, has been reused by multiple cities and institutions around the world. The options of the software can be tailored depending on the specific needs of the institutions using it, by, for instance, choosing to implement only some features (out of the five used by Decide Madrid) or developing novel sections. A 2020 study[70] shows that among 51 other use cases of the Consul software, the participatory budgeting option was the most popular feature, implemented in 33 cases (65 percent of the cases). In addition, most often only one feature of the software has been implemented.

Conclusions and Recommendations

Digitalisation is opening novel ways for enhancing efficiency in cities but also for ensuring that citizens' feedback is considered in building smarter and more sustainable cities. In the transformative process of rendering cities smarter, more sustainable, and more resilient, engaging citizens effectively is a key component[71] of mapping issues, crowdsourcing ideas and solutions, and contributing to the effective implementation of smart city policies.

67. Pina, V., Torres, L., Royo, S., & García-Rayado, J. (2019). Decide Madrid: A Case Study on E-Participation. Tropico project. Available at: https://tropico-project.eu/cases/administration-costs-for-bureaucracy/decide-madrid-a-case-study-on-e-participation/. Last accessed: 7 December 2021.

68. Decide Madrid. Soluciones a problemas técnicos (FAQ). Available at: https://decide.madrid.es/mas-informacion/faq. Last accessed: 7 December 2021.

69. The share of participants from different age groups was as follows: 7.95% for 16 to 29; 39.15% for 30 to 44; 36.38% for 45 to 59; 13.72% for 60 to 74; 2.74 for over 75. Data available at: Decide Madrid. Presupuestos participativos 2019: Estadisticas. https://decide.madrid.es/presupuestos/presupuestos-participativos-2019/estadisticas. Last accessed: 7 December 2021.

70. Royo, S., Pina, V. and Garcia-Rayado, J. (2020). Decide Madrid: A Critical Analysis of an Award-Winning e-Participation Initiative. Sustainability 12, no. 4: 1674, p. 12 https://doi.org/10.3390/su12041674

71. Sassen, S., Kourtit, K. A (2021). Post-Corona Perspective for Smart Cities: 'Should I Stay or Should I Go?'. Sustainability 13, 9988; pp. 11-12. https://doi.org/10.3390/su13179988

Smart city strategies have been a focal point of the policy agendas of both ASEAN and the EU, and more recently a relevant element of the ASEAN-EU strategic partnership. In creating smarter cities, the role of citizen participation has been recognised to different extents in the two regions. Nevertheless, citizen participation for smart cities can be further bolstered. ASEAN and the EU can support local developments by enhancing cooperation and supporting the exchange of best practices within and between the two regions with respect to creating opportunities for citizen participation in local decision-making and urban development. Several key lessons can be drawn from the case studies selected and based on the relevant literature.

Ensuring an inclusive approach. Digital tools usher in a new approach in engaging citizens and crowdsourcing information, feedback, and solutions. Digital tools need, nevertheless, to be paired with offline solutions to ensure wide accessibility and inclusion.

Providing intuitive means of participation. Multiple online tools can be deployed to boost citizen participation. In designing these tools, clarity, conciseness, and an intuitive approach are essential to ensure that citizens remain engaged and that they are compelled to use the same tools in the future as well. User centricity and user friendliness are thus essential for the effectiveness of the tools.

Creating feedback loops and clear connections to the decision-making process. For citizens to provide their input in participatory processes, it is necessary to explain how their feedback is expected to be used and to ensure follow-up throughout the implementation phase. Both in the case of Tanjong Pagar urban development and Decide Madrid, clarity concerning the policymaking process was emphasised as a

relevant aspect. In the case of Tanjong Pagar, the relative attractiveness of the participatory project was impacted by the long distance in time between the provision of feedback and the actual expected implementation of urban development projects in the district. In the case of Decide Madrid, the need for a reinforced feedback loop about the implementation of projects proposed by citizens was emphasised.

Promoting reusable solutions. The exchange of best practices and use cases can be bolstered by promoting those solutions that are more readily reusable and free of charge. The case of the open source software "Consul" used by Decide Madrid is relevant in this respect, showing the extent to which a citizen participation solution can be taken up and replicated in multiple countries.

Encouraging partnerships. Finally, other stakeholder groups can play an important role in helping deploy citizen participation tools. As the case of Tanjong Pagar shows, academia can act as a strong supporter by prototyping and testing solutions.

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HEALTHCARE
& WELL-BEING

DIGITAL INSIGHTS: FUTURE OF CITIES

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SMART HEALTH: Improving Public Healthcare System in Cambodian Cities

SOCHEATA SAR **VATANA CHEA**

Introduction

From an economic perspective, cities are formed to provide cost advantages to producers and consumers. For instance, firms can locate themselves close to one another to save transportation costs. Additionally, firms of similar industries may benefit from being located in the same cities so that they can learn from one another, draw on a large pool of workers with specific skills used in that sectors, or derive advantages from specialized infrastructure, e.g., Silicon Valley in the United States or Shenzhen in China. In addition, workers with specialized skills appropriate to the industries may also prefer to stay in the particular location to find a new job or be in a position to take advantage of better opportunities.

But as the world population increases, with estimates indicating that it will reach 9.6 billion people in 2050 and 10.9 billion in 2100,[1] many issues have also emerged. Some of the main concerns related to the rapid urbanization rate[2] include natural resource depletion, traffic congestion, waste management, pollution, natural disasters, increasing price of real estate, and extremely high living costs.[3] For instance, apart from having an issue with urban governance due to rapid urbanization, Pakistan is also facing problems concerning the lack of access to habitations, infrastructure crisis, transportation disasters, crowded classrooms, limited employment, and low-quality public healthcare services.[4]

The Cambodian case might not be an exception due to the dramatic urban population expansion over the last decade.[5] But fortunately, solutions have also been proposed to make urban development sustainable, and the Phnom Penh residents would be provided with safety, proper facilities, and quality governance and administration. Such solutions would include using advanced Information and Communication Technology (ICT) and beyond to support the cities' progression towards sustainability and revolutionize the urban way of living. And the proposition to incorporate digital technologies and infrastructure into the city's development plan has led to the invention of the innovative "Smart City" concept.[6]

The Smart City concept can be traced back to the Smart Growth Movement in the late 1990s.[7] While a traditional city normally consists of an urban area, residents, and a system of infrastructures that can meet social requests, a smart city has all three elements plus a system of network and a smart platform that allows for data collection.[8] But bear in mind that there are also many other definitions of and approaches for a smart city. In one instance, economists

1. United Nations Department of Economic and Social Affairs, *World Population Prospects: The 2019 Revision* (New York: United Nations, 2019).

2. United Nations, Department of Economic and Social Affairs Population Division, "World Urbanization Prospects: The 2018 Revision" (Washington D.C, 2018).

3. Organization for Economic Cooperation and Development, *OECD Environmental Outlook to 2050: The Consequences of Inaction* (Paris: OECD Publishing, 2012).

4. Nasira Jabeen, Umm-e- Farwa, and Musa Jadoon, "Urbanization in Pakistan: A Governance Perspective," *Journal of the Research Society of Pakistan* 54, no. 1 (2017): 127–36.

5. Vatana Chea and Patcharawalai Wongboonsin, "Children of Internal Migrants: Does Moving with Parent(s) Affect Schooling Progression?," *SOJOURN: Journal of Social Issues in Southeast Asia* 35, no. 3 (2020): 437–62.

6. Ritu Mohanty and Bipin Pradeep Kumar, "7 - Urbanization and Smart Cities," in *Solving Urban Infrastructure Problems Using Smart City Technologies,* ed. John R B T - Solving Urban Infrastructure Problems Using Smart City Technologies Vacca (Elsevier, 2021), 143–58, https://doi.org/https://doi.org/10.1016/B978-0-12-816816-5.00007-3.

7. Colin Harrison and Ian Abbott Donnelly, "A Theory of Smart Cities," *Proceedings of the 55th Annual Meeting of the ISSS - 2011, Hull, UK* 55, no. 1 SE- (September 23, 2011), https://journals.isss.org/index.php/proceedings55th/article/view/1703.

8. Alberto Vaquero-García, José Álvarez-García, and Marta Peris-Ortiz, "Urban Models of Sustainable Development from the Economic Perspective: Smart Cities," in S*ustainable Smart Cities: Creating Spaces for Technological, Social and Business Development,* ed. Marta Peris-Ortiz, Dag R. Bennett, and Diana Pérez-Bustamante Yábar (Switzerland: Springer, 2017).

define a smart city as an urban area in which infrastructure and human and social capital allow for sustainable economic development and improvement in the quality of life of its residents through collaborative governance.[9] On the other hand, the European Union refers to the term "smart city" for sustainable development projects or plans of action aimed at improving urban spaces that continue to play a vital role in socio-economic growth.[10] Since then, the smart city concept has become widespread, and many countries seek to establish one through advanced technology and modern infrastructure to combat the challenges of urbanisation and rapid population growth. In concept, smart city consists of multiple interrelated components, including smart people and communities, smart industrialization, smart transportation, smart infrastructure, smart environment, smart security, smart economy, smart education, and smart health. The latter concentrates on expanding the healthcare services in a way that traditional healthcare could not and making public healthcare friendly, accessible, and feasible for everyone in need using recent Information and Communication Technologies and digital devices such as the Internet of Things (IoT).

This article's prime objective is to look into how a smart health system functions to provide better public health services and raise people's awareness of their health status in the context of growing smart cities. In particular, our goals are threefold. First, we will critically examine the existing literature discussing the concept of smart health. Second, we will show the connection and influence between smart cities and smart health and how such interconnection can

improve the public health of the residents, who will, in turn, contribute significantly to the development of smart cities. Third, we analyze major challenges in promoting smart health and well-being of people in the context of Cambodia and present some pragmatic solutions.

Overview of Smart Health

Around the world, many developed and developing countries face public health challenges, including traditional healthcare systems with limited resources and service delivery, and only some privileged people can access them. Such challenges would typically include underdeveloped hospital infrastructure, obsolete medical equipment, and undereducated medical practitioners trained with outdated knowledge. As a result, they could not provide patients with proper healthcare services. This is not to mention that the medical profession in some countries is not very well-respected, and medical doctors have often failed to earn citizens' trust and acknowledgment owing to the fact that some of them do not adhere to professionalism and ethics. They might, on the other hand, provide false information on healthcare, wrong prescription of medications, or unnecessary treatments to rip patients off. The Covid-19 pandemic has been both a menace and a testifier to the frailty of the healthcare system in many countries. It has shown that the existing healthcare system was not well-established and could not fully serve people in times of crisis.

But these days will soon be far behind us. Deprivation and challenges can be used as opportunities to innovate. In this regard, the world has now paid more attention to the idea of smart health, which aims to improve the capacity of quality and timely healthcare delivery. Smart health is a crucial component

of smart city development, and it should not be confused with electronic health (e-health), which is a broader concept also containing the smart health itself if we look from the public health perspective.[11] Moreover, it should also be highlighted that the notion of smart health goes beyond the use of simple mobile phone applications related to health or healthcare.

Figure 1: Smart Health in Smart Cities.
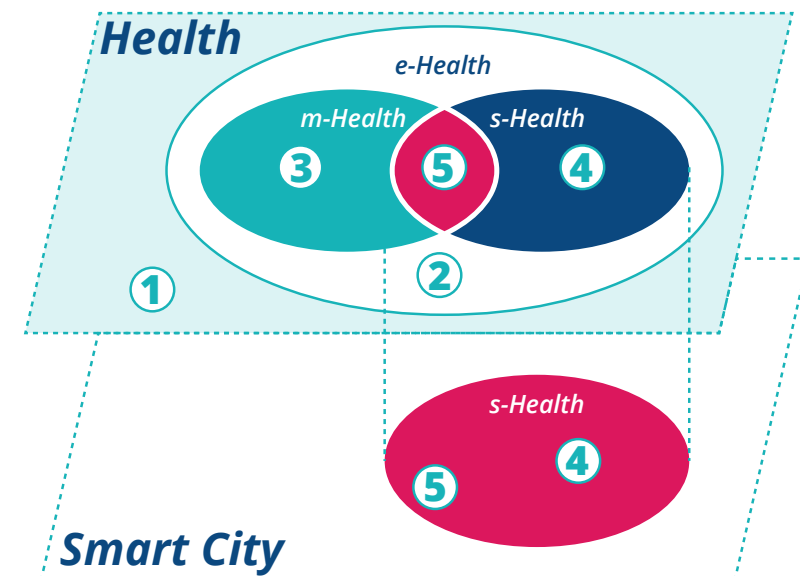
Source: Majed Kamel Al-Azzam and Malik Bader Alazzam (2019). #1 = traditional health, #2 = electronic health, #3 = mobile health, #4 = smart health, #5 = smart city.

Figure 1 illustrates the difference between smart and electronic health and how smart health is linked with the smart city. In traditional healthcare (notion #1), there involves doctors and conventional tools and methods for treatment that require no ICT devices. For the notion of electronic health (notion #2), technologies started to be incorporated into healthcare service delivery to store patients' medical records and history. In contrast, m-health (notion #3) in practice would allow patients to access their medical prescriptions using a mobile phone which would also be used as a reminder for the patients to follow medical advice regularly. On notion #4 (smart-health), which is our interest, information about the patients, including sleep patterns and blood sugar level, and their surrounding environments, such as the level of dust and pollution, is gathered through technological devices such as IoT, and useful information for the patients would be then transferred back to the patients to combat potential health issues and unhealthy behaviors. Note that such information is generally known as big data, collected and monitored by the healthcare provider and data experts. But it can also be used by the government agencies for development purposes, including forming social securities and pensions. It's important to note that there are areas of overlap or connection between smart and mobile health. In practice, these areas typically involve the use of digital devices

9.   Taewoo Nam and Theresa A. Pardo, "Smart City as Urban Innovation: Focusing on Management, Policy, and Context," in *5th International Conference on Theory and Practice of Electronic Governance, ACM,* 2011, 185–94.

10. Harrison and Donnelly, "A Theory of Smart Cities."

11. Majed Kamel Al-Azzam and Malik Bader Alazzam, "Smart City and Smart-Health Framework, Challenges and Opportunities," *International Journal of Advanced Computer Science and Applications* 10, no. 2 (2019): 171–76.

to convey and receive information. For example, consider a scenario where a driver who wears a smartwatch with built-in accelerometers gets into an accident, which is immediately detected by the smartwatch itself due to a high vibration rate caused by the collision. The watch would automatically send a notification about the accident and its location along with the victim's biography to the nearest hospital (smart infrastructure) to request an ambulance. If this is confusing, it may help to know that mobile health focuses more on delivering medical care services to specific patients and typically involves the use of personal data, whereas smart health is primarily concerned with public health and sensing health infrastructure in the context of smart cities.

But what is the interconnection between smart health and smart city, then? Again, as the figure has indicated, smart health is an element of a larger concept – the smart city. Therefore, it is illogical to develop a smart city without including the smart health aspect since healthcare is a fundamental need for humans and the smart city concept is there to fundamentally improve the quality of life and public services. If one is unhealthy, one will not be so keen on other components such as education. That said, ICT devices were regarded as the key enabler connecting the smart city and smart health. It enables system-to-system communication, enabling medical personnel—including technicians, doctors, nurses, and caregivers—to learn more about their patients without having to speak with them or ask them to physically transfer their data from one doctor to another. The medical staff can also acquire, check, analyze and make real-time decisions from different hospitals in crowded urban or remote areas. In reality, no such fully and comprehensively modernized smart health system is in place yet. But there has been an attempt to do so in China since 2013, yet they

are facing some problems with information system infrastructure, big data collection, and smart applications.[12] However, some countries partially adopt the concept of smart health, which we will illustrate in the following section.

Applications of Smart Health Around the World

Even though the development of smart health is still in its infancy, the applications of smart health can be seen in many countries. But bear in mind that it is not always explicitly understood as "smart health." For example, In Australia, a country well-known for its fast-forward adoption of computer and communication technology, the smart health concept has led to the invention of a new technology called smart card.[13] Such technology permits movable computerized medical records and provides several preferable options to store health-related information and data, which was complete, trusted, and well-timed. Other prime advantages of the smart card technology include keeping account of the medical records, prescribed medications, vaccination history, emergency-response information, and biography of the card holders. Suffice to say that with the smart card, the medical records in the Australian context would be vastly improved and become more concrete, precise, and systematic.

Another application of smart health could be seen in Bangladesh[14] and Pakistan,[15] where IoT-based smart healthcare services for rural underprivileged people have been adopted. The IoT-based smart healthcare services ease the progress of physical healthcare monitoring systems, including medical consultation. In addition, medical specialists can conduct real-time patient observation remotely without needing to go to the site. Recently, Bangladeshi and Pakistani firms have also extended such healthcare services using mobile and web-based virtual telemedicine conferences. The government has also suggested that public and private medical care facilities and hospitals improve the quality of their healthcare through the use of IoT-based gadgets, such as healthcare trackers and applications, wearable healthcare devices, and sensors, so that healthcare services are more readily available, prompt, and practical for people no matter where they live. Owing to this fact, it is predicted that there will be huge adoption of IoT-based smart devices related to healthcare by 2025, and that will foster better relationships, credentials, and trust among medical technicians and patients.[16]

Implementation in Cambodia

Having demonstrated the use of smart health in a few countries, it is probably also useful to talk in the context of Cambodia. Before we begin the discourse, it is worth

noting that even with the advancement in healthcare, there can still be room for diverse and complex challenges in implementing the smart health concept, especially in the developing world. However, we are by no means saying that it is impossible to implement such a concept in Cambodia because it has already been done by other developing countries in the region which have lower gross domestic products and/or population levels of education.

From our perspective, at least three challenges need to be addressed when the country decides to opt for smart health. First, poverty is still a major issue. According to the latest government figures published by the National Institute of Statistics, the poverty rate in Cambodia is roughly 17 percent - this was not helped by the recent COVID-19 pandemic, making livelihoods more troublesome. But the problem with poverty is that people will find it difficult to access better healthcare even physically, let alone by using digital devices and technology, which may be beyond their range of affordability. Note that poor people also tend to be low-educated and digitally illiterate. In addition, they are likely to work in the difficult and dangerous sectors of the economy, such as construction work, increasing their risk of fatal accidents. In addition, they normally face serious issues that would lead to chronic health crises, including hunger, infectious diseases, malnutrition, low sanitation, and basic hygiene malpractice.

Second, the health workforce in developing Southeast Asian countries in general, Cambodia in particular, is still in shortage.[17] In fact, such a shortage issue has also been raised by the Ministry of Health,

12. M Guo et al., "An Overview of Smart City in China," *China Communications* 13, no. 5 (2016): 203–11, https://doi.org/10.1109/CC.2016.7489987.

13. S Morris et al., "Australian Healthcare: A Smart Card for a Clever Country.," *International Journal of Bio-Medical Computing* 40, no. 2 (October 1995): 101–5, https://doi.org/10.1016/0020-7101(95)01132-x.

14. Mohammad Monirujjaman Khan, "IoT Based Smart Healthcare Services for Rural Unprivileged People in Bangladesh: Current Situation and Challenges," *Proceedings of 1st International Electronic Conference on Applied Sciences Proceedings of 1st International Electronic Conference on Applied Sciences*, no. 4 (2020).

15. Zulfiqar Ali Solangi, Yasir Ali Solangi, and Zulfikar Ahmed Maher, "Adoption of IoT-Based Smart Healthcare: An Empirical Analysis in the Context of Pakistan," *Journal of Hunan University (Natural Sciences)* 48, no. 9 (2021): 143–53.

16. Solangi, Solangi, and Maher.

17. Churnrurtai Kanchanachitra et al., "Human Resources for Health in Southeast Asia: Shortages, Distributional Challenges, and International Trade in Health Services.," *Lancet (London, England)* 377, no. 9767 (February 2011): 769–81, https://doi.org/10.1016/S0140-6736(10)62035-1.

Cambodia in recent years. In addition, there is a maldistribution of qualified healthcare personnel, and many qualified health workers can only be found in the urban cities, while healthcare centers in rural areas tend to be understaffed, undertained, and underpaid. Given the scarcity and limited skills of health workers, the quality of healthcare delivery is also jeopardized regardless of whether or not it is done using a digital system. Moreover, the coverage is substantially restricted. After all, no health workers can work 24/7 to meet millions of people's demands for healthcare services even though they are very skillful.

Third, the development of technology requires a huge investment in the form of upfront cost in not only health but also in big data, transportation, education, and other necessary infrastructure that support health and healthcare, including stable and reliable internet in urban and rural regions. Not to mention that patients have to be digitally literate and aware of the concept of smart health and how it works, and that will need another investment in terms of financial resources and time to train people. Otherwise, only the rich or the privileged will enjoy smart-health advantages, and the poor will be excluded from the proper smart healthcare system. Eventually, they still have to seek physical medical care with a long queue, low-quality services, cost-ineffective provision, and time-consuming journey to the hospital.

Concluding Remarks and Policy Implications

In a nutshell, with the introduction of the smart city and smart health concepts, many more lives can be saved than with traditional healthcare practices alone. Smart health can also lead to sustainability, better accessibility, outstanding reliability, and more mobility,

as well as social and economic expansion in the long run. However, there are problems that we have to solve first before we can enjoy the advantages. But while we have raised the challenges, we also prefer to be part of the solution. Below are our pragmatic suggestions.

Invest in Smart Health Infrastructure

First, technology development needs a lot of investment, but the good news is that we can spread the investment over a long period. And the better news is that the investment in technological knowledge has already been made, and at the current stage, Cambodia can just learn from other countries. The government should also strictly demand foreign firms to transfer their technology to the local people, or offer investment incentives to those firms bringing in beneficial technologies to the Kingdom. If it can be done, the country can substantially reduce the investment cost in inventing technological knowledge or ideas. Note that smart health ideas should be non-rivalrous from the economic perspective. Ideas or knowledge can be shared with almost zero additional cost.

Increase Digital Health Capacity

Second, the government should work closely with the research-intensive universities or research institutes in Cambodia, especially those specialized in science and technology, because universities are the place that produces knowledge and conducts research and innovation to invent new technologies and advance our scientific understanding. The university of science and technology is also a business enterprise where tech solutions are provided to industries, and the government can, in a similar gesture, fund their research to do exactly the same, providing tech solutions and technologies

for the local smart health development projects. Funding research can also generate positive externalities. For once, it will produce new technological knowledge which can be shared freely.

Include Ethics Components in STEM Courses

Third, the university curriculum for medical doctors, engineers, and scientists should always include ethics, humanity, and philosophy subjects so that they are trained to be compassionate, empathetic, and considerate people. The "character" part should also be put in the "knowledge" part delivered to them. A doctor without compassion and empathy will not help improve the healthcare system as he or she will only treat the rich and ignore the poor. An engineer without consideration is nothing better than a robot and the smart system he or she creates. After all, they just do as they are told. A scientist without humanity might even pose more dangers to society than the benefits of having him around. Simply put, he or she is unlikely to invest anything useful for society, and we want someone that will contribute to the development.

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MIND THE GAPS FRAMEWORK ANALYSIS: The Case Study of Tokyo's Urban Mental Health Design and Implications for Phnom Penh

OUDOM OUM

"Health is always the most important topic in urban planning. When we had the Meiji Restoration, a priority topic was health."
– Tokyo's urban planner.[1]

Urban environments and mental health issues are closely interconnected. Cities are associated with a higher prevalence of mental health issues compared to rural areas. Urban dwellers have a 40% higher risk of depression, are 20% more likely to suffer from anxiety, and have higher incidences of schizophrenia. It is clear that if a city is to be truly "smart" in the future, it must carefully consider the mental health of its citizens.

Poverty, unemployment, overcrowding, noise pollution, poor infrastructure, and lack of green space are identified as the several basic factors that negatively affect urban mental health.[2] Urban planning is one of the most effective tools to not only navigate the growing mental health illnesses in the city but also to promote mental health and wellbeing by making the city more human-centered and livable. The Centre for Urban Design and Mental Health advocates for the Mind the GAPS Framework, which aims to build better urban mental health through smart urban planning. GAPS Framework explicitly considers green places (natural settings in neighborhoods), active places (integration of active movements in daily routine), pro-social places (positive, safe, and natural interactions in the community), and safe places (integrated sense of safety and security in people's mental health and well-being).[3]

Tokyo is, undeniably, the most populous urban city in the world with a population of approximately 37 million residents in 2022, a number that is equivalent to more than double Cambodia's total population.[4] This huge population has to come with highly practical urban planning and design which aims to not only monitor the living access and conditions of all Tokyo citizens but also the mental health management of every inhabitant in the city. Therefore, this article especially aims to examine urban mental health planning in Tokyo by first looking into the practical existence of urban planning and design in metropolitan Tokyo under the analysis of the GAPS Framework. Beyond this, a concrete reflection on the policy and regulation frameworks aiming to maintain a lively urban mental health condition of its over 37 million residents will also be offered through each GAPS point. The article will also depict recommendations for the urban development of Phnom Penh city, deriving from the practical examples of Tokyo.

Mind the GAPS Framework

Formulated by **The Centre for Urban Design and Mental Health**
www.urbandesignmentalhealth.com

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Urban Mental Health Design in the Tokyo Metropolis: GAPS Framework

Japan is not a country with the best example of mental health. A survey conducted by the World Mental Health Japan with 4,000 people in 2016 found that the lifetime prevalence of common mental illnesses in Japan is one in five people, which is lower than in many Western countries.[5] This challenge is caused by several social and cultural conditions, including honorable suicide following unemployment and financial problems, health attacks, stroke, and suicide associated with 'karoshi' (death by overwork). None of these are often related to urban designs.

Mental health associated with urban planning and design in Tokyo is at another level. Tokyo is virtually more than a city, but a metropolitan prefecture comprising 23 special wards, in which each is governed as separate cities, plus 26 more cities, five towns, and eight villages, pursuing a complicated assignment in terms of smart urban planning.[6]

As **green places** are important for a healthy urban livelihood, the Tokyo Greenship Action programme was introduced by the Tokyo Metropolitan Government (TMG) in 2003. This program aims to conserve green spaces by partnering with local companies and non-profit organizations to preserve private greenland. Moreover, the government even has a system to buy the most important natural areas, if the land owners are unable

to do so.[7] In 2010, Tokyo's Comprehensive Policy for Preserving Greenery, introduced under the TMG's guideline, led to the designation of special districts and zones in Tokyo. With this policy, actions focused on promoting greenery, including special green space conservation districts that conserve and promote urban green spaces; large-scale suburban green space conservation zones (with an aim to maintain and improve healthy minds and bodies of urban and suburban livers); and scenic districts aiming to conserve urban scenic beauty and environment have been enforced, which are explicitly adding a greater number of green urban and suburban spaces to the city.[8] Beyond that, the Tokyo Environmental Master Plan and the Tokyo 2020 Action Plan were introduced in 2016, aiming to make Tokyo greener in preparation for the Tokyo Olympic Games in 2020.[9]

As of April 01, 2020, the total number of urban parks and parks other than urban parks are more than 8,000 locations across Tokyo, covering approximately 8,009 hectares of land. Of those green areas, metropolitan parks managed by the Bureau are located in 82 urban places across the city, covering 2,030 hectares, while municipal parks are located in 8,203 locations of 3,745 hectares.[10] This is not yet counted in the other two national government parks that are hugely set in the middle of the metropolis. In Tokyo, parks could be often found in all districts across the city.
Moreover, the creation of greenery

networks and prosocial open spaces as part of large-scale urban development has been also encouraged under the TMG's guideline for Greenery Development in Privately-Owned Public Spaces, resulting in an increase in privately-run parks across the city.[11] In 2007, Kankyojiku guidelines were published by TMG, offering networks of urban spaces around roads, rivers, parks, and infrastructures that are 'lush with greenery' and creating a network of 'environmental green axes' throughout the city. The Kankyojiku Council was established the following year to share lessons and promote the development of these areas in the networks.[12]

However, these policies and frameworks alone are not enough. Green space development would be even more successful and practical when the citizens engage. Machizukuri, a method of inter-community dialogue aiming to build community capacity and cooperation through engagement between the members of the community and local governments,[13] has been also integrated into the greenery development process. Tokyo citizens have been empowered in community design. Plant plots and tree bases are planted and maintained by the community residents in tiny public spaces near their homes, ostensibly greening the city at the individual level. By encouraging individual participation, workshops and methodology for greening spaces, along with tax intensives to such efforts, have been offered by the TMG to assist and encourage

residents, making Machizukuri an active cycle of participation between residents and government officials.[14]

Besides green spaces, active places are also important for designing a positive urban mental health as well. Since public transportation is more accessible, affordable, efficient, and effective for its average residents, Tokyo becomes a city of commuters (the average one-way commute to work is around 45 minutes) instead of car ownership with only 0.46 cars per household.[15] This lifestyle naturally and automatically generates a light-exercise routine for individual Tokyo active residents through active transport, including walking, cycling, and accessing public transit.

The success of public transit in Tokyo, including the high usage of public trains, contributes to a healthy mentality for its citizens, as people are actively commuting more in the public. However, overcrowding in train carriages can also cause the opposite as discomfort and stress among the users, especially during busy business (rush) hours (generally morning and evening, before and after work). Besides, cycling and walking have become very common in Tokyo. Around 14 percent of the journeys in Tokyo each day are made by bicycle, mostly for short trips of less than 2 kilometres,[16] while walking generates an active routine for people to access train stations.

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Pro-social places in Tokyo involve public spaces that are often the epicenter of positive and natural social interaction in a city. Public parks, train station plazas, temples and shrines, indoor public places, shopping places, bars, offices, places for older people, post-disaster places, and many other places have been all designed not only to bring greater socializing access for the city inhabitants but are also more accessible to evacuate in the case of earthquakes.[17] Moreover, in Tokyo, cars and buses are managed to keep mostly to the main streets, making a block or two off the principal thoroughfares tranquil, leafy areas conducive to community activities, including walking, running, and other social interactions.[18]

Furthermore, beyond the infrastructure level, TMG prioritizes the maximum attention of the **safe places** in the communities by maintaining its very low crime rate and preparing to safeguard its populations from natural disasters. The barrier-free design aspirations, including residential housing, public amenities, and transportation help not only promote a sense of safety for living in Tokyo but make the surroundings more movable and accessible for older people and people with disabilities.[19] Unlike Phnom Penh, sidewalks in Tokyo are well managed to keep clear for walkers. Many of the sidewalks are lined with yellow panels, some with raised lines, others with raised dots like *legos,* but these blocks were made to simply help aid those with visual impairments or blindness while they are in the public spaces.[20]

How Can Phnom Penh's Urban Design Be Better for Urban Mental Health?

Phnom Penh is not a particularly mental-health-friendly city, as can be ascertained with a simple mathematical comparison. There are only 70 parks[21] to serve a population of 2.8 million people[22] in Phnom Penh - a ratio of one park for every 40,000 citizens. This compares to a ratio of one park for every 3,750 citizens in Tokyo, a much larger city. Beyond that, the sidewalks in Phnom Penh are poorly managed as being occupied by an extension of shops, street foods, and parking lots, decreasing the movable access of the city inhabitants and discouraging them from being associated with active places.[23] With a limited public transportation system as 16-line city buses are offered, Phnom Penh residents often prefer their own ridership, using individual motorbikes and cars to access work or school, worsening the traffic congestion in the capital.[24] Beyond that, safety and severe urban flooding after rain seemingly add another level to the stressfulness of the city residents, intensifying urban mental health issues in Phnom Penh. However, there are ways we can learn from Mind the GAPS Framework, sampled by Tokyo urban design, and apply it to the smart urban design of Phnom Penh for mentally healthier residents.

- **Green Places:** The multiparty engagement is essential to building

a sustainable cycle of green areas in the city. A City Environmental Master Plan is needed to designate green areas, implement policies and offer incentives to build a greener Phnom Penh. Green zones shall be redesigned based on community conditions, which solidify easy accessibility for the community livers on the ground. The building of green spaces and parks in each district or community is an ideal mechanism to strengthen the mental health of the community residents. With this initiative, the city government shall partner with the private sector or local companies to conserve green spaces and preserve private greenland in designated areas for greenery. Moreover, the Machizukuri model is important to engage more with the neighborhood residents in the green design of the common spaces at the individual level, making it a shared responsibility to keep their municipal park green and lively. Building sustainable urban greenery demands a three-way approach: government-to-private-sector, government-to-people, and private-sector-to-people.

- **Active Places:** The integration of active movement into the daily routine of individual residents is important to destress urban mental health. As public transportation in Phnom Penh is not advanced and useful, the mobility of the city residents is often made by their individual vehicles. Walking and cycling are not popular in the city, even for a less than 10-minute-walking destination. Consequently, people are more stressed, not only because they are inactive, but also because of increasing traffic congestion which normally takes hours on cars and motorbikes during

busy business hours. With this, the development of advanced public transportation, including high-speed city trains, is important. The system is not only to reduce the individual usage of vehicles, which causes traffic congestion but also to increase the active movements of the people as they have to walk to access the train or bus stations. Moreover, essential agendas, policies, and incentives shall be made and implemented by the city government to promote active walking and cycling in the city, at least for less than a 10-minute-walking destination. By decentralizing access to basic places to the neighborhood level, including schools, hospitals, markets and malls, common spaces, parks, administrative buildings...etc, the cross-district movements will be lowered, while walking and cycling will be more convenient and comfortable for the community residents. Accessible sidewalks shall be fairly managed and organized as well to ensure there are no extensions of small businesses on the sidewalks that make them difficult and inconvenient for community walkers.

- **Pro-social Places:** Urban design shall facilitate more inclusive and positive interactions among people and promote a sense of community, integration, and belonging among the community residents. The multi-faceted engagement from passive observation to active participation by creating flexible and movable public spaces to increase the socializing accessibility among all groups of people, including young and older people, women and men, migrants and refugees, and people with disabilities. This is often seen in big Boreys in Phnom Penh, where places for social

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interaction are offered like mini-plazas, community restaurants, picnic spots... etc. which are not usually seen in any typical communities. Moreover, when public parking spots are rearranged and managed properly to clear the sidewalks, the neighborhoods will be more interactively accessible among community residents, bettering the social-interacting environment. After all, this form of pro-social places shall be considered.

- **Safe Places:** Clear sidewalks, appropriate street lighting and surveillance, distinct landmarks, and people-centric design of residential, commercial, and industry routes are significantly important to ensure the sense of safety and security in the urban liver's mental health and wellbeing. Addressing crimes and maintaining a safe and non-polluted environment, including the noise pollution, are the common principles in building a safe place for urban livers, where people could enjoy life without any mental fears of criminal attempts and mental disturbances. Sidewalks shall be lined with yellow panels, raised lines, and raised dots like legos, while crosswalks shall be built with signal sounds which are often to assist people with visual impairments or blindness.

Conclusion

In summary, the Mind the GAPS Framework, often used to explain the smart urban design in Tokyo, is the initial stage for urban planners to consider a smart urban design for better urban mental health of Phnom Penh. These infrastructure proposals may be counter-argued as a huge budget is needed, from building a small municipal park to high-speed trains. However, this article aims to provide a basic consideration for the future master plan and urban design of Phnom Penh rather than proposing a fresh [re]start of a massive infrastructure development in the city for the current stage. Urbanization is rapidly emerging in Cambodia, in which 36 percent of the total population is expected to live in urban areas by 2050. Therefore, a new master plan for smart urbanization is inevitably needed. This plan must lead to a smarter Phnom Penh city. One that that is human-centered, future oriented, and crucially, that takes urban mental health carefully into consideration. After reading this article, I hope you share my same conclusion.[25]

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edited by

Mr. Robert Hör and Mr. Thomas Hesketh

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