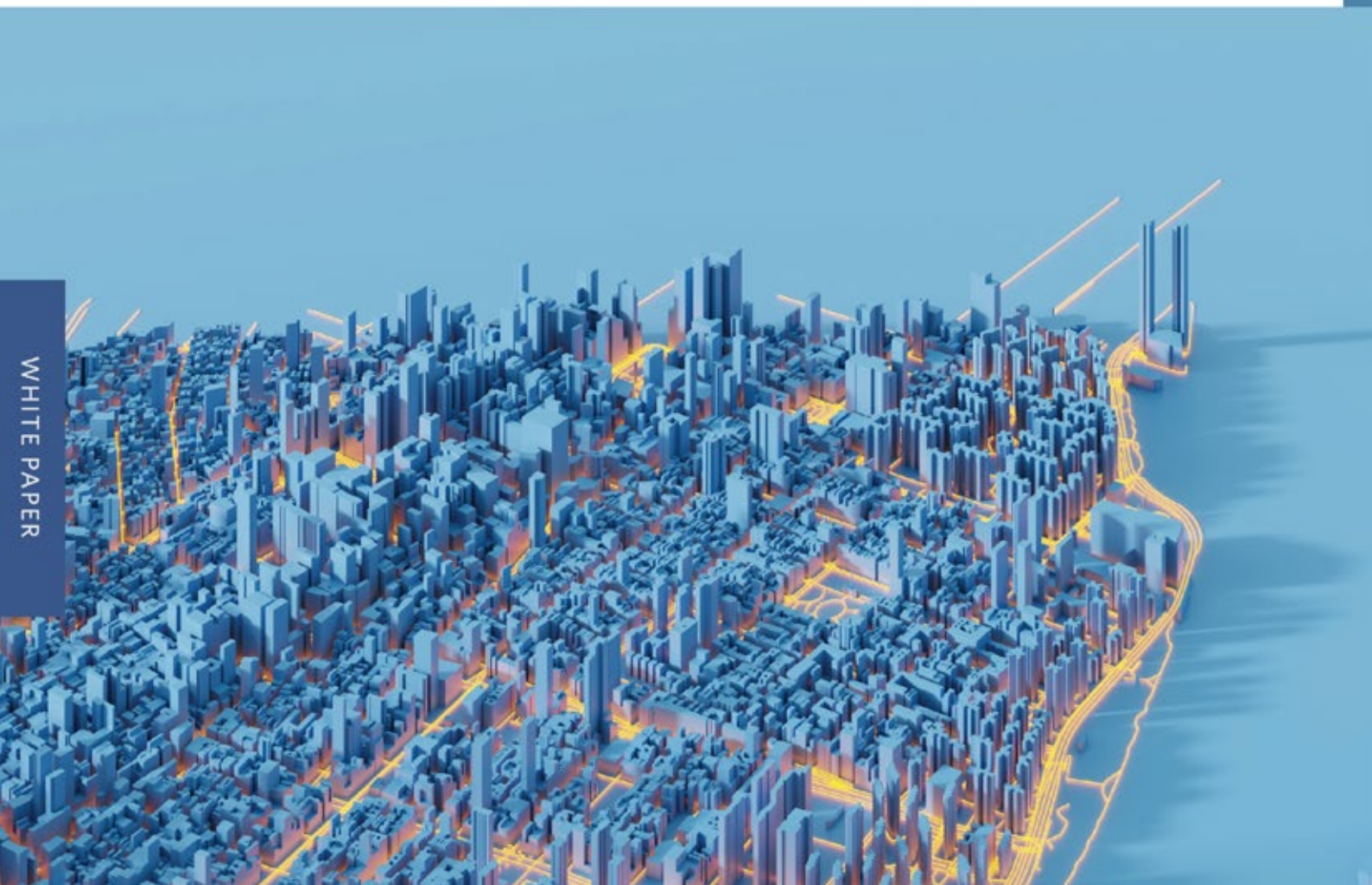
SMART CITY FRAMEWORK AND GUIDANCE FOR THAILAND

Smart City services for Phuket

2019

WHITE PAPER



ACKNOWLEDGEMENTS

The Phuket Smart City White Paper would not have been possible without generous contributions of various governmental and private organizations

First and foremost, to Office of the Governor of Phuket, Digital Economy Promotion Agency (depa), and the National Smart City Committee for their invaluable inputs, support and guidance towards developing the national and provincial Smart City strategy. Sincere appreciation to the agencies and associations driving the development of Smart City in Phuket, in the key strategic areas of the province. Phuket City Municipality, Kathu Town Municipality and other municipalities of Phuket for their generous support and guidance in understanding the issues Phuket is currently facing. Phuket Tourist Association and Federation of Thai Industries (Phuket Provincial Office) for their contribution in crafting smart solutions to actively push for the advancement of Phuket. Last but not least, Tourism Authority of Thailand and Department of Provincial Administration for sharing their experience in dealing with obstacles encountered by Phuket.

Sincere appreciation to various public and private stakeholders, especially those who graciously participated in multiple expert interviews and workshops to voice their concerns, put forward their ideas and collectively formulate the Smart City initiative recommendation for Phuket. Gratitude towards the local Smart City initiative holders, who shared their passion and experiences, and provided their views on the way towards transforming Phuket into a pilot Smart City for Thailand. And lastly, to the joint Huawei and Roland Berger team, who conducted and facilitated the analyses for the successful development of the White Paper.

FOREWORD

Air Chief Marshal Prajin Juntong

Senator

Smart City development initiative will allow Thailand to take advantages of modern technology and innovation to not only increase the well-being of Thai people, but also enhance the efficiency of businesses across different industries. As being part of Thailand 4.0 initiative, Smart City development will play an important role in supporting the technology advancement and digitalization ecosystem development in Thailand.

Smart City development is expected to scale across the national level with Phuket as the essential pilot city. Smart City will help address as-is situation & challenges across social, environmental and economic aspects of provinces.

In this report, Huawei together with many stakeholders, from both private and public sectors, have developed a comprehensive Smart City framework that can be used to scale across and beyond Phuket. Moreover, a study methodology has also been formulated to support the Smart City service prioritization and service recommendations for stakeholders in other provinces.

I believe that this Smart City white paper report will be an important guidance to raise awareness on the importance of Smart City and align the understanding on the framework and required methodologies to support the successful development of Smart Cities across and beyond Phuket.

(Air Chief Marshal Prajin Juntong)

Senator

FOREWORD

Mr.Phakkhaphong Thawiphat

The provincial governor of Phuket

Asst. Prof. Dr. Nattapon Nimmanpatcharin

President/CEO
Digital Economy Promotion Agency (depa)

Thai government has been focusing on the development of digital economy and society in order to enhance Thailand's competitiveness. It is clear that Smart City will be one of the most important initiatives in supporting technology and innovation development across different industries. Moreover, the development of Smart City will help address challenges faced and unlock the potential of the economy.

This report has integrated the opinions and ideas from both public and private agencies to support on the Smart City service prioritization and detailed business model development for Phuket. Key development component including 17 Smart City services and 8 service enablers, are also investigated and addressed interestingly.

I believe that the framework and methodology used to support the Smart City recommendations in this report will be useful as a development guideline for relevant stakeholders to successfully scale the Smart City development at the national level

Smart city development is one of the government's top priority and considered national agenda with a view of using digital technology and innovation for people to lead a better quality of life with less social disparity and equitable development in all regions of the country. Smart city is being defined as "a city that leverages technology, innovation, and good design to increase efficiency, cut costs, and innovate in relation to smart city management and service provision, with participation from all relevant stakeholders, in order to achieve citizen's quality of life and happiness as well as sustainability."

As co-secretariat of National Smart City Committee, depa has developed action plan and set the target for smart city development in Thailand, Year 1 (2018 - 2019), developing 10 cities in 7 provinces, namely Phuket Khon Kaen, Chiang Mai, Chonburi, Rayong, Chachoengsao and Bangkok; Year 2 (2019 - 2020) developing 30 cities in 24 provinces and year 3-5 (2020-2022), expanding smart city development through smart city proposal which is expected to cover 100 cities in 76 provinces and Bangkok. Phuket is one of the first pilot cities for smart city transformation.

I strongly believe that this "Smart City Framework and Guidance for Thailand: Case of Phuket" will provide useful recommendations and guideline for relevant stakeholders at the local level, and be used for further development of smart cities in Thailand and beyond.

(Mr.Phakkhaphong Thawiphat)

The provincial
governor of Phuket

(Asst. Prof. Dr. Nattapon Nimmanpatcharin)

President/CEO
Digital Economy Promotion Agency (depa)

APPRECIATION FOR STAKEHOLDERS' PARTICIPATION

This report would not have been possible without the kind participation from the stakeholders we have engaged, both public and private, who have provided their valuable vision and experience.

National level

- Thailand 4.0 & Smart City initiator

depa

สนข
สำนักงานนโยบายและแผนการขนส่งและจราจร

กระทรวงพลังงาน
MINISTRY OF ENERGY

Provincial level

- Governor & Municipalities

- Smart City initiative stakeholders

อาคเนย์ประกันภัย
SOUTHEAST INSURANCE

D-KIDS

PKCD
ภูเก็ตพัฒนาเมือง

FLOWLOW
TRAVELER'S FRIEND

การประปาส่วนภูมิภาค
Provincial Waterworks Authority

- Potential service operators & users

ปภ.

โรงพยาบาลกรุงเทพ ภูเก็ต
BANGKOK HOSPITAL PHUKET

RENAISSANCE
PHUKET RESORT & SPA

Prince of Songkla University

กรมเจ้าท่า

EXECUTIVE SUMMARY

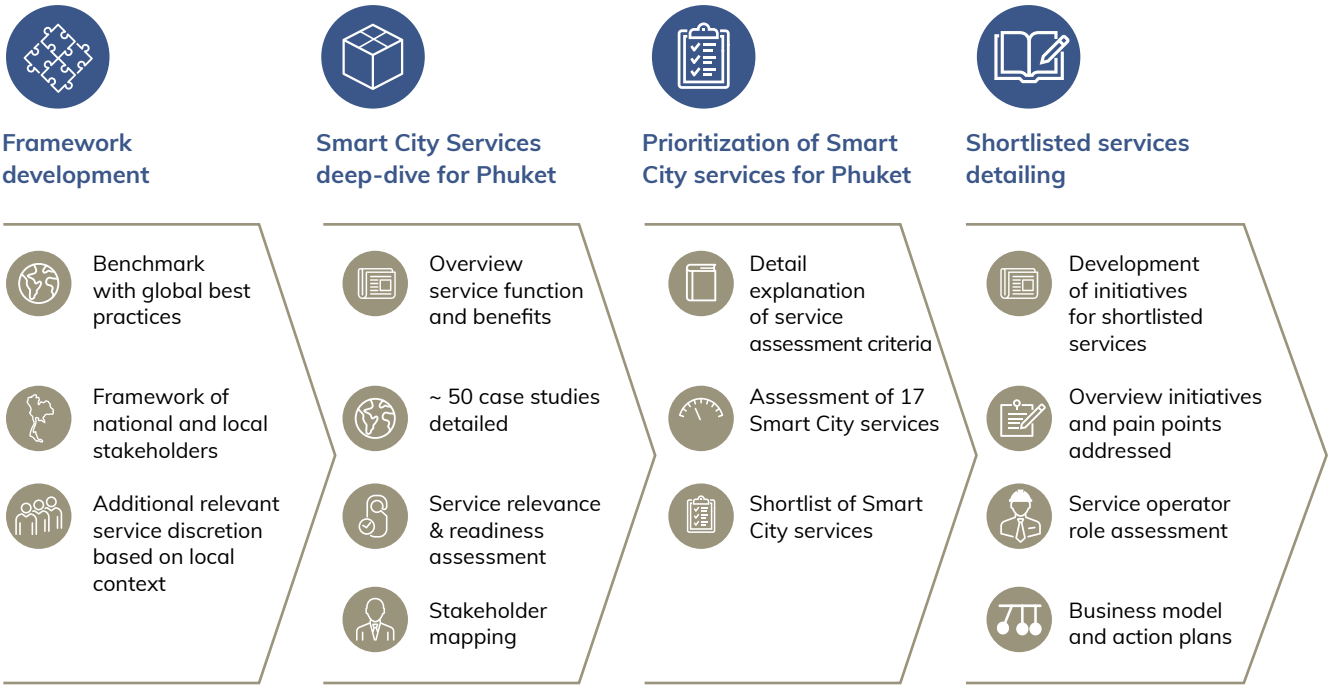
Thailand 4.0 has been announced by Thai government to unlock the country from several economic and social challenges by leveraging technology and innovation. Smart City is one of the most important initiatives of Thailand 4.0 as the development of Smart City will act as a supporting infrastructure for innovation development across different industries.

Currently, there are 7 cities (Phuket, Chiang Mai, Khon Kaen, Chonburi, Rayong, Chachoengsao, and Bangkok) that were selected for Smart City pilot cities. The development of pilot cities are categorized into two waves. First wave consists of Phuket, Chiang Mai and Khon Kaen and second wave consists of Chonburi, Rayong, Chachoengsao (EEC) and Bangkok.

This whitepaper will focus on Phuket as Phuket is not only selected for the first wave of the pilot cities, but Phuket also has been supported by both local and national stakeholders to support in the framework and roadmap development.

In this whitepaper, we have developed the universal Smart City framework to support the development in Phuket and nationwide scalability. We then conducted assessments of 17 Smart City services to identify the service relevance based on existing pain points and situations in Phuket to support the service prioritization and recommendations.

Below picture illustrates the overview methodology of our study to support the service identification and recommendations for Phuket



From the above methodology, there are six Smart City services that have strong potential to address pain points and enhance the competitiveness of Phuket in the short run. We believe that these six services can be quick-win services for Phuket. Below is the list of six services.

- Smart Electric Metering
- Smart Traffic Light
- Smart Public Transport
- Smart Waste Management
- Integrated CCTV System
- Smart Tourism

From the engagement with local stakeholders and secondary research, we believe that Smart Electricity Metering should be prioritized in Phuket as Phuket has a rapid increase in electricity consumption with growth rate higher than those of national average as well as of Southern region. Smart Electric Metering is expected to provide end users with real time electricity consumption monitoring so that they can better control their electricity expenses.

Smart Traffic Light can potentially be a quick-win service launch to address existing heavy traffic congestion issues especially in urban areas. Phuket has high no. of registered vehicle per capita and many intersection across Phuket are not be able to support real-time adjustments based on traffic flow volume during rush & non-rush hours. Smart Traffic light aims to collect real-time traffic flow information which will be further processed by the central control system to automatically or partly automatically adjust light duration and frequency of the light.

Smart Public Transport also receives high prioritization scoring as heavy traffic congestion has been one of the key issue for Phuket and is also expected to remain the same in the near future. Moreover, Phuket has high volume of registered vehicles on the road. Hence, there is a need for Smart Public Transport that centralizes real time information of all public transport modes to facilitate and eventually encourage the usage of public transport for commuters

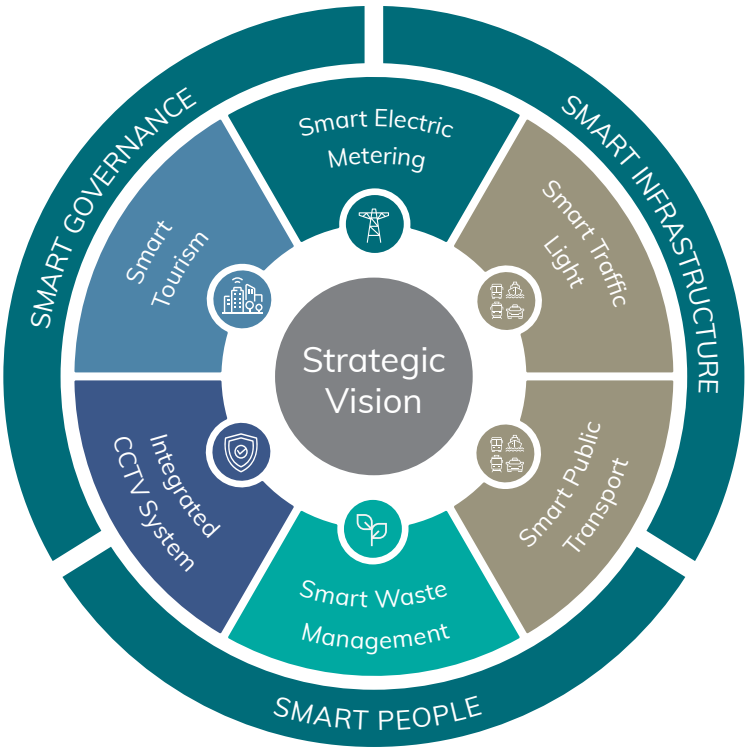
Smart Waste Management is expected to address waste problems & pain points for the service operator. Phuket has a large volume of annual generated waste per capita when compared to the national average as well as limited supporting infrastructure such as landfill and waste incinerator resulting in large volume of uncollected and untreated waste. This solution allows the service operator to measure and track waste level with alerts to the operations center when their capacities are nearly full as well as with route planning optimization for rubbish trucks during waste collection process.

Integrated CCTV system is highly relevant to as-is situation and pain points in Phuket. Phuket has a higher number of population per one police officer as compared to the national average as well as lots of existing installed CCTVs are not yet fully integrated across the province to support instant alert notification. Integrated CCTV solution allows the operator to collect and monitor real-time information in different areas which then can support instant alert sending to the responsible officers.

As tourism is one of the major economic drivers for Phuket, we believe that Smart Tourism will further enhance competitiveness of Phuket in this industry and address pain points related to tourism. Currently, Phuket lacks a collective data platform that can be shared among relevant entities. Moreover, the province still lacks a centralized service that is easily accessible by visitors/ tourists in order to facilitate smooth travelling experience. Therefore, Smart Tourism solution is expected to enhance tourists' experience and strengthen the tourism industry in Phuket.

The above 6 shortlisted services are highly relevant to Phuket's strategic vision for achieving high living quality for citizens and enhancing the province competitiveness. We have also identified service enablers that can support the quick-win launch of shortlisted services in Phuket. Below is the summary of vision and service recommendations for Phuket.

"Smart island that leverages advanced technology infrastructure to **achieve high living quality for citizens and enhanced tourism** to drive its economy"



6 shortlisted Smart City services that are expected to address **as-is issues and enhance competitiveness** of Phuket

9 service initiatives detailed and organized across public and private sectors

Supporting

3 key enabler groups identified to support **service operations and scalability** across Phuket and beyond

CONTENTS

CHAPTER

01

THAILAND SMART CITY CURRENT SITUATION

THAILAND NEEDS SMART CITIES TO TRANSFORM INTO A HIGH INCOME NATION

Overview of Smart Cities in Southeast Asia

During the 32nd ASEAN Summit in March 2018, the ASEAN Smart Cities Network initiative (ASCN) has been initiated with the aims to:

- Facilitate cooperation on Smart Cities development by exploring potential collaboration, sharing best practices, etc.
- Catalyze bankable project – Member cities will be linked up with solution providers from private sector to kickstart their project
- Secure funding from ASEAN external partners – Member can pair up with specific external partners e.g. World Bank, ADB, AIIB, GIH etc. to form partnership and secure funding

With these ASCN's pilots, major cities in SEA are being fast-tracked to transform into Smart Cities. Major cities in Thailand are no exception, as various initiatives are already underway to transform them in to Smart Cities.

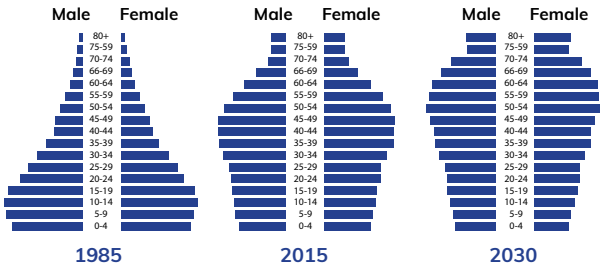
Figure 1: Map of ASEAN Smart Cities Network

Source: ASEAN Smart City Network

Thailand is facing a rapid increase in urbanization, energy consumption and ageing population

As the nation is moving from a developing country to being a developed country, trends such as the rapid increase in urbanization, energy consumption, ageing population and rising healthcare costs are amongst many being encountered by Thailand. The incorporation of Smart City technologies will, to a certain degree, facilitate a smoother transition from the old to the new. For instance, Telehealth service can reduce costs of travelling and improve access to healthcare, especially for elderlies in remote areas; Smart Mobility can reduce congestion in metropolitan areas such as Bangkok; Smart Waste Management can improve the livability of countless communities.

Figure 2: Trends in ageing population of Thailand



Source: World Bank

Thailand Industry 4.0 will transform Thailand into a high income nation

The government of Thailand has launched a national agenda to push the country to become a high-income nation. The initiative is often coined as the "Thailand 4.0" economic model. The four key objectives of Thailand 4.0 initiative include:

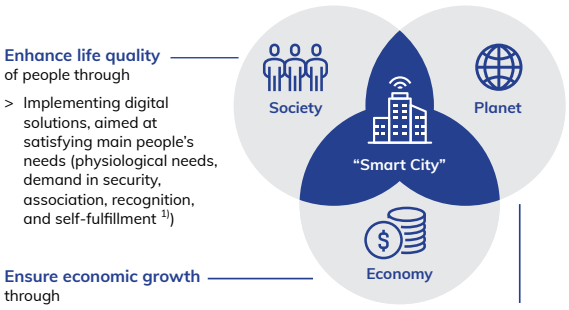
1. Economic prosperity: To create a value-based economy driven by innovation, technology and creativity
2. Social well-being: To create an inclusive society through the realization of the full potential of all members of the society
3. Raising human values: To transform Thais into competent human beings in the 21st century and Thais 4.0 in the first world
4. Environmental protection: To become a livable society that possesses an economic system capable of adjusting to climate change and low carbon society

Important actions being implemented at the moment involve focusing on 10 high-value and high-tech industries, known as the S-curve industries. The S-curve industries can be further segmented into 2 main types, the "S-curve" and the "new S- curve". S-curve includes traditional industries such as automotive, medical tourism, electronics, food technology and agriculture. These are industries which Thailand is particularly strong at, but technologies can be used to further boost their values. On the other hand, the new S-curve are industries which are somewhat technologically new to the country but, with the current ecosystem and environment, are seen to have high potential. This group of industries include robotics, biofuels, medical hubs, digital sector and aviation.

The key goals of Smart City focus on the society, the economy and the environment

Smart City technologies were devised to enhance life quality of people through implementing digital solutions, aimed at satisfying people's needs (physiological needs, demands in security, association, recognition and self-fulfillment). At the same time, the technologies must also ensure economic growth through increase of public services provision efficiency and enhancing their values, as well as new commercial opportunities. Finally, Smart Cities must raise the level of environmental protection through protecting and optimizing consumption of natural resources, as well as the decrease of hazardous substance emissions and waste disposal.

Figure 3: Key attributes of Smart Cities



Enhance life quality of people through

> Implementing digital solutions, aimed at satisfying main people's needs (physiological needs, demand in security, association, recognition, and self-fulfillment [1])

Ensure economic growth through

> Increase of public services provision efficiency and enhancing their value
> New commercial opportunities

Enhance the environment through

> Protecting and optimizing comsumption of natural resources
> Decrease of hazardous substance emissions and waste disposal
> Developing public "green" spaces
> Advance forecasting techniques

Source: Roland Berger

Thailand needs Smart City to achieve the "Thailand 4.0" target

Apart from economic goals, Thailand 4.0 also aims to improve social well-being of Thais and protect the environment amidst the rapid industrialization. In order to achieve this, it is crucial for Thailand to adopt Smart City initiatives, for instance, the monitoring and control of waste and air pollution effectively.

In terms of the economy, many of the S-curve industries mentioned previously, especially the new S-curves, require a strong foundation in digital, transport and public infrastructure, resulting in more interest for Smart Cities to be developed in the country.

In 2017, Deputy Prime Minister, Prajin Juntong, said in a speech that the aim is to have "100 Smart Cities within two decades to improve the quality of life in urban centers". As a result, 7 pilot Smart Cities have been launched in provinces of high potential including Phuket, Chiang Mai, Khon Kaen, Bangkok and the 3 EEC provinces (Chonburi, Rayong and Chachoengsao).

Different types of Smart Cities require different smart initiatives

It is important to appreciate that there are different types of Smart Cities requiring different smart solutions. Generally in Thailand, Smart Cities can be grouped into 3 categories: 1) Legacy City, 2) New City and 3) Industrial/ Business Park.

Legacy City is the one which already has physical and institutional structures in place but is experiencing sharp population growth and rapid urbanization. The city can benefit from technology-based initiatives aiming to improve efficiency and livability and create additional values. Examples of these cities are the key major cities like Bangkok and Phuket. Legacy cities will be the focus of this report.

The second type is the New City category. This is the city that has been built without any existing smart technologies or infrastructures. This will result in New City, which is designed to attract businesses and residents with a master plan that uses best-in-class technologies and IT system. Examples of these are the 3 EEC provinces, Chonburi, Rayong and Chachoengsao.

The last type is the Industrial/ business Park type. As with the development in the cities, industrial and business parks can also leverage digital technologies to enhance productivity, efficiency and livability. This includes development of Smart Traffic, Smart Utilities Management, Smart Security, creating demands in Smart City solutions from industrial estate and business park developers. Examples in Thailand are still limited, but many leading industrial estates such as Amata and WHA have claimed that they are transforming their estates into Smart Cities.

In all cases however, public-private partnerships (PPP) is essential to Smart City development as both the expertise from Smart City solution provider and infrastructure access from public side are required.

The Smart City Development Committee was established to support national Smart City initiatives

To promote and facilitate the Smart City initiatives, the Thai government has set up the National Smart City Committee, a collaborative effort from Ministry of Digital Economy and Society, Ministry of Energy as well as Ministry of Transport. In addition, they are able to commission support from Permanent Secretaries from 10 other ministries as well. Core action plan from the Smart City Development Committee can be grouped into four main points as follow.

- To develop a strong and systematic mechanism for public-private partnership
- To create a Smart City development masterplan, encompassing a city data platform and analytics
- To build the ideal ecosystems for Smart City development through public infrastructure improvement
- To promote innovative solutions and startups in Thailand

Figure 4: Public agencies involved in Smart City

Main objective : To establish a mechanism to drive smart city development in Thailand, facilitate smart city projects, and monitor their progress

Office of the Prime Minister of Thailand

> Launched nationwide Thailand 4.0 economic development in July 2016 to push Thailand forward into the 21st century

Key Ministries

Ministry of Digital Economy and Society

> Develop and promote digital economy and Society to increase the country's competitiveness and to heighten the well-being of Thai poppulation

Ministry of Transport

> Develop integrated transport system to raise the quality of life of Thai poppulation and sustainably drive the country's economy

Ministry of Energy

> Maximize regional resources effectively to promote and achieve sustainability and innovation goals

Key state agencies as co-secretariat

Digital Economy Promotion Agency (depa)

> Define national-level smart city framework, develop province-level strategic plan and implement pilot and prototype projects

Office of Transport and Traffic Policy and Planning (OTP)

> Improve the quality of life through smart transport systems that help foster a safe and clean environment

Energy Policy and Planning Office (EPPO)

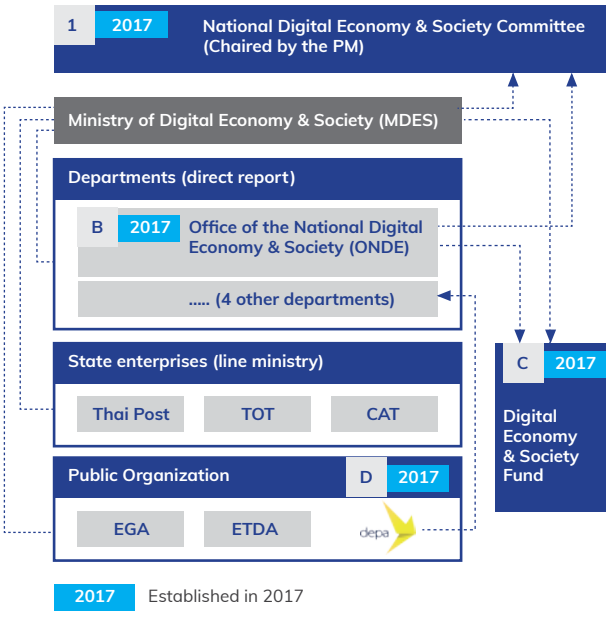
> Formulate and administer energy policies and planning for national sustainability leveraging energy innovation

Source: Roland Berger

A number of government agencies are working towards establishing Smart Cities, notably depa

As the formation of Smart Cities will inevitably require collaboration between both private and public sectors, it is crucial to understand the roles in which each government agency relating to Smart City plays. There are four major public stakeholders which should be considered regarding Smart City. Their roles and importance are elaborated below.

Figure 5: Structure of related government agencies



Source: Digital Economy Promotion Agency (depa)

1. National Digital Economy & Society Committee is in charge of setting National Policy and Master Plan on all digital-related topics. The committee is chaired by the Prime Minister with Deputy Prime Minister as the chairman, along with 11 other cabinet members from 11 Ministries including Ministry of Digital Economy and Society (MDES). Members also include high-ranking officials in related agencies, for instance, Secretary General of Office of the National Economic and Social Development Council (NESDC), Governor of Bank of Thailand, Permanent Secretary of MDES (as Secretary) and Director of Office of the National Digital Economy and Society Commission (ONDE) (as Deputy Secretary).

2. ONDE supports the National Committee in development of draft policies and master plans related to digital initiatives. It is the coordinator between government agencies in implementing digital initiatives and is also in charge of monitoring their progress. The director of ONDE sits on the Board of Digital Economy Promotion Agency (depa).

3. The National Digital Economy and Society Fund was created to fund digital initiatives. The board consists of Deputy Prime Minister, Minister of MDES, Permanent Secretary of MDES, Director of ONDE, Minister of Finance, Budget Bureau Director and 3 experts.

4. depa was created in 2017 as a public organization combining Software Industry Promotion Agency (SIPA) with selected teams from the Ministry itself. depa is the key agency who promotes the use of digital technologies by government agencies and private sector. depa also works with ONDE on Digital Economy Development Master Plan and is governed by a Board consisting of a Chairman appointed by the Minister of MDES, Permanent Secretary of MDES and Director of ONDE, as well as 4 other members appointed by the MDES.

Roles of depa in Smart City development span from national to provincial level

depa is no doubt the key government agency related to Smart City as they are responsible for formulating the masterplan and providing support from the national level down to provincial level. depa's action can therefore be segmented into three stages.

1. On a national level, Directors of depa are responsible for setting the national framework and providing support, in the following areas:

    - Promote development and adoption of Smart City solutions by government agencies and businesses
    - Support startups' growth and promote knowledge sharing
    - Build environment that supports Smart City development
    - Develop Smart City framework as guidelines for what Smart City services include
    - Decide which provinces to become Smart Cities and allocate budget to each province – These are set based on direction of MDES

2. On a provincial level, District Managers of depa are in charge of planning development whereby they report to Directors of depa. Some of their roles include the following:

    - Set up provincial working committee with the following structure:
        > Vice-Governor as Chair
        > depa as secretary
        > Digital agencies, e.g., CAT, NSTDA, etc.
        > Municipalities in the province
        > Local representative from selected government agencies, e.g., Provincial Police, Provincial Land Transport Office, etc.
        > Local academia and businesses

    - Develop Strategic Plan for provincial level with the following:
        > Areas of focus and projects to do
        > Additional budget required from the province on top of what is already allocated

3. Implementation of initiatives is also carried out by District Managers of depa on the provincial level. A standard process includes the following:

    - Seek approval for budget from the province (Provincial Digital Committee)

    - Conduct projects as per outlined in the Strategic Plan upon receiving budget approval
        > depa may do the projects themselves or work with local government agencies, businesses and academia
        > Projects shall involve "proof of concept" and "prototype development" (e.g. sensors in a small farm)
            - Raise awareness and understanding of Smart City services
            - Provide workable solutions that can be used by government agencies and businesses in the future

depa's Smart City Development Roadmap stretched from 2018 to 2036

depa drew up a national Smart City roadmap, spanning from 2018 to 2036, with a number of key milestones along the way. In 2018, depa started by establishing a National Steering Committee along with a Smart City Master Plan, leading to the foundation of 7 area-based action plan for 7 pilot cities and special zones.

Currently in 2019, 7 pilot cities have been launched and 20 other cities are in the stage of planning development under partnership for potential Smart City projects. Moving forward, depa envisioned the number of Smart City locations to increase over the years, from 7 today, to 27 in 2020 then to cover almost the entire nation in 2022. Furthermore, depa hoped that in 2036, at least 1 Smart City in Thailand will be placed amongst the world's top 10 Smart Cities, and also for at least 3 cities in Thailand to make it to the world ranking.

Smart City developments in Thailand are facing 2 main challenges – Delays and pain point misalignments

Many innovative initiatives have already been envisioned and planned, however with delayed process prior to launch. The key reasons are delay in government approval process, limited support and funding from key stakeholders and lack of tech expertise and necessary innovations to achieve the pre- defined objectives. depa and all of the committees and agencies mentioned previously, cannot act alone to execute Smart City initiatives, only through collaboration will a full- fledged Smart City be realized. Collaboration is especially crucial with the following stakeholders:

- Local government
- Agency responsible for that particular sector, e.g., energy, transport, etc.
- Private sector and local businesses

Another common obstacle is pain point misalignment, whereby some identified pain points specific to the local context have not been addressed by both planned and ongoing initiatives. Lack of deep-dive analysis to obtain key insights on city's actual situation and demand is one of the potential root causes. Many of the pilot projects were launched for the purpose of prototyping, which is no doubt extremely useful. However, more actual demand is needed. Services launched in the future will need to be more demand- based in order to generate income and become sustainable in the long run.

Phuket is one of the leading Smart City pilots in Thailand, with a strong focus on tackling tourism-related issues

Phuket has been selected by the government as part of the first wave of pilot Smart Cities, alongside Chiang Mai and Khon Kaen. The government envisioned Phuket to become international hub in 2020, focusing on tourism, public safety environment and government. A government funding of USD 13 million was commissioned to develop the city and carry out initiatives to boost local economy by 4.5% in the next 5 years.

However, as a result of the huge influx of tourists, Phuket still has many unaddressed problems, which could be tackled by using Smart City technologies. Major issues include poor sanitation, inefficient waste management and public safety. An analysis of the issues, along with the strategy and action plan will be explored in detail in later chapters.

Phuket is arguably the most advanced smart city in Thailand due to key drivers across multiple areas

Phuket is amongst the first wave of smart cities in Thailand. However, unlike the other smart cities, Phuket has multiple key drivers in various areas, whether be the exponentially growing number of visitors every year, limited infrastructure readiness to cope with growing demand and competition from neighboring tourist destinations. These key drivers have pushed stakeholders, both public and private, to initiate change, whether in smart waste management, smart transportation and city data analytics, to name a few tangible examples. However, despite a handful of implemented initiatives, Phuket still has areas which urgently need to utilize smart city technologies, for instance traffic management, security systems and tourism. Considering the current momentum and the urgent needs, Phuket is selected as the subject for our deep-dive investigation. As mentioned by a key stakeholder driving Phuket smart city;

– “Phuket can become a leading smart city in the region, and set example for other cities in Thailand; although our key drivers are unique, our solutions can be shared with other cities across the country”.

A government funding of USD 13 million was commissioned to develop the city and carry out initiatives to boost local economy by

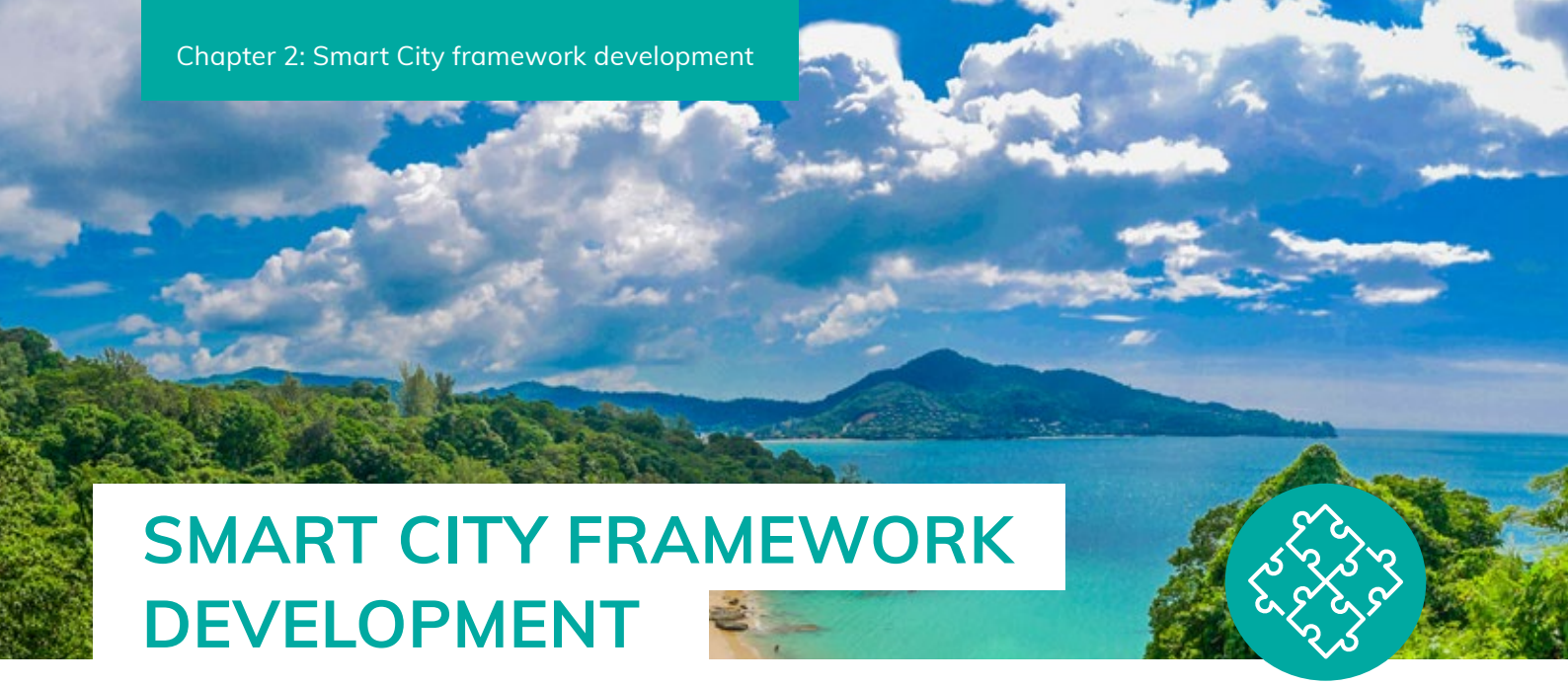
4.5%

in the next 5 years.

CHAPTER

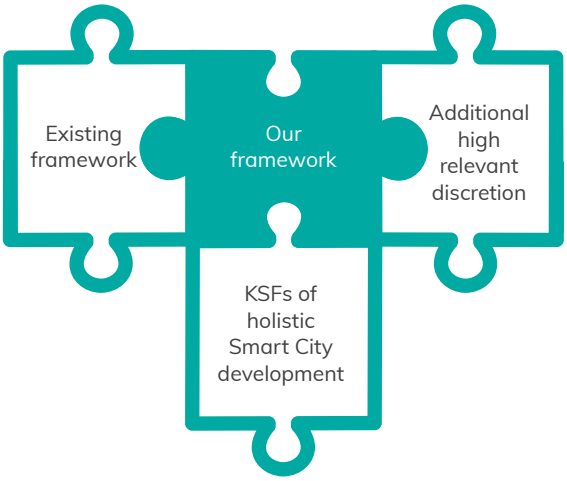
02

SMART CITY FRAMEWORK DEVELOPMENT



SMART CITY FRAMEWORK DEVELOPMENT

The framework is an essential first step for Smart City development as it helps the province/ city or country scope high potential services to enhance the competitiveness and increase life quality of citizens. Our Smart City framework has been developed from mixture of sources as illustrated below.



The developed Smart City framework in our scope has two main components, service vertical and service enabler which are crucial components for the successful development of Smart City.

Service Vertical – Our framework covers a variety of service verticals. Each service vertical is expected to address and/ or enhance key certain aspects of the city. Each service vertical can also consist more than one solution. For example, Smart Energy vertical consists of Smart Grid, Smart Electric Metering, Smart Water Metering and Smart Lighting. Service vertical in our scope only includes services that are digitalized and have strong potential to improve competitiveness of the city.

The level of relevance of service vertical can be different across cities as each city has different economic status, demographic background and development plan. Therefore, each city is required to identify current problems and situation as well as where the city wants to be in the future in order to prioritize and select the most relevant services for the Smart City development.

Service Enabler – Service enablers are required for the development of Smart City services. Service enablers usually involve connectivity, data center, broadband and infrastructure, etc. which can be leveraged across service verticals. Smart City developer is required to develop all service enablers to support the launch of Smart City services. Service enabler is different from service vertical as it does not directly address city problems but rather acts as the necessary supporting tool to ensure the successful launch and operation of service vertical.

Our Smart City framework has been developed to ensure that the government agencies and other private stakeholders cannot only leverage this framework to address existing issues and enhance competitiveness of Phuket as a pilot province launch, but also scale this framework at the national level. Our developed framework is aligned with the existing frameworks developed by local/ national parties. The following parts of this chapter will elaborate on the framework development methodology as well as brief description of service verticals and enablers.

Existing Framework

For framework development, it is important to understand as-is development plan of key stakeholders. Digital Economy Promotion Agency (depa) and Phuket City Development (PKCD) are selected as two key stakeholders as they are relevant on the development of Smart City at both national and provincial levels. They have played important roles in supporting both Smart City ecosystem as well as planned and ongoing initiatives.

Digital Economy Promotion Agency (depa)

– depa plays important roles in supporting startups to develop Smart City solutions and also involves in many pilot projects at national level. depa believes that Phuket is one of the most potential provinces that can support the development of Smart City, thus depa has developed framework and masterplan to ensure that all aspects of Phuket will be fully addressed by Smart City solutions.

depa's framework consists of the following items:

Framework items	Descriptions	Relevant component
Smart Environment	> IoT connectivity & environment related solution	> Service Vertical
Smart Living	> Enhanced quality of life, safety and happiness of residents	> Service Vertical
Smart People	> Development of manpower and educational infrastructure	> Service Vertical > Service Enabler
Smart Governance	> Capabilities to execute and operate Smart City	> Service Enabler
Smart Economy	> Increase in productivity and efficiency of local businesses	> Service Vertical
Smart Mobility	> Improvement of commercial and public transport	> Service Vertical
Smart Energy	> Increase in energy usage efficiency	> Service Vertical

Framework items developed by depa are both service verticals and enablers which is aligned with depa's objective of being a Smart City developer to support ecosystem and provide open platform development at both provincial and national levels.

Phuket City Development (PKCD)

– PKCD is a joint venture of private businesses in Phuket incorporated under the concept of Social Enterprises. The key objective is to develop Phuket toward Smart City to drive the competitiveness and to become the world smartest leading tourist destination. Currently, PKCD works with both private and public parties such as municipalities to initiate and launch Smart City services in Phuket.

PKCD's framework/ masterplan consists of the following items:

Framework items	Descriptions	Relevant component
Smart Transit	> Development of transportation and ocean marina	> Service Vertical > Service Enabler
Smart Energy	> Enhancement of alternative energy supply infrastructure	> Service Enabler
Smart Tourism	> Promotion of Phuket's destinations and local businesses	> Service Vertical > Service Enabler
Smart City	> Safety and knowledge development for locals	> Service Vertical > Service Enabler

As the key objective of PKCD establishment is to support the Smart City development in Phuket, thus the developed framework items are more in line with Phuket's as-is situation and local needs.

Additional High Relevance Discretion

In addition to existing framework developed by key stakeholders, we also need to ensure that the framework can exhaustively enhance all different aspects and uniqueness of Phuket in the long run. For example, we have added Smart Waste Management which is categorized under Smart Environment to our scope as we believe this service will help local governments address fast growing amount of generated waste due to growth in population and visited tourists. In addition, we also added Smart Energy which covers Smart Water Metering and Smart Lighting to help local authorities reduce cost of operations from remote meter recording and automatic light bulb management.

As mentioned earlier, our framework scope has been incorporated from mixture of sources which means that some Smart City services will be more relevant than other services due to needs and as-is situation of the city.

Vienna, Austria

Singapore

Seoul, South Korea

Hong Kong

Key Success Factors of Holistic Smart City Development

We have selected 4 cities that are in top 10 of the Smart City index ranking developed by Roland Berger. These cities have successfully implemented Smart City solutions to address pain points with tangible realized benefits from the solution.

In the following part of this section, we will cover the detail of case studies and also the common key success factors across these selected case studies:

Country	Descriptions	Addressed pain points
Vienna, Austria	> Principle lies on "providing the best quality of life" > Smart City initiative began in 2011 and has been widely acknowledged for its success	> Rising demand for energy leading to concerns in growing carbon footprint and detrimental effects to the environment > Rapid rise in population, leading to higher healthcare, traffic and governmental concerns
Singapore	> Integrated smart solutions in all functions in an effort to become a "Smart Nation" > Smart Nation Platform that integrates many sources of information for Singapore development	> Increase in population leading to complications in sustaining high quality of life > Ageing population that requires healthcare and living assistance > Rising demand for energy, leading to concerns on growing
Seoul, South Korea	> Smart City plan focusing on 5 cityspecific key issues, bringing together administrative functions of all offices and departments of government > Vision to provide the best ICT infrastructure, adopt open government, strengthen publicprivate partnership and adopt latest technology	> Ageing population and steadily decreasing citizen physical activity levels putting pressure on healthcare services > Need to improve safety and living quality of city's population > High level of air pollution
Hong Kong	> Smart City Blueprint, the city's development plan, aiming to address urban challenges and improve city management using innovation and technology, improve people's quality of living and achieve sustainable economic development	> High vehicle density on the road causing traffic congestion > High electricity consumption resulting in high carbon emission and large amount of solid waste

From above selected case studies, each city has pursued the development of Smart City services to address the pain points and enhance the competitiveness of the city. Majority of developed Smart Cities are implemented with high level of integrations across different solutions and high level of supports from all stakeholders.

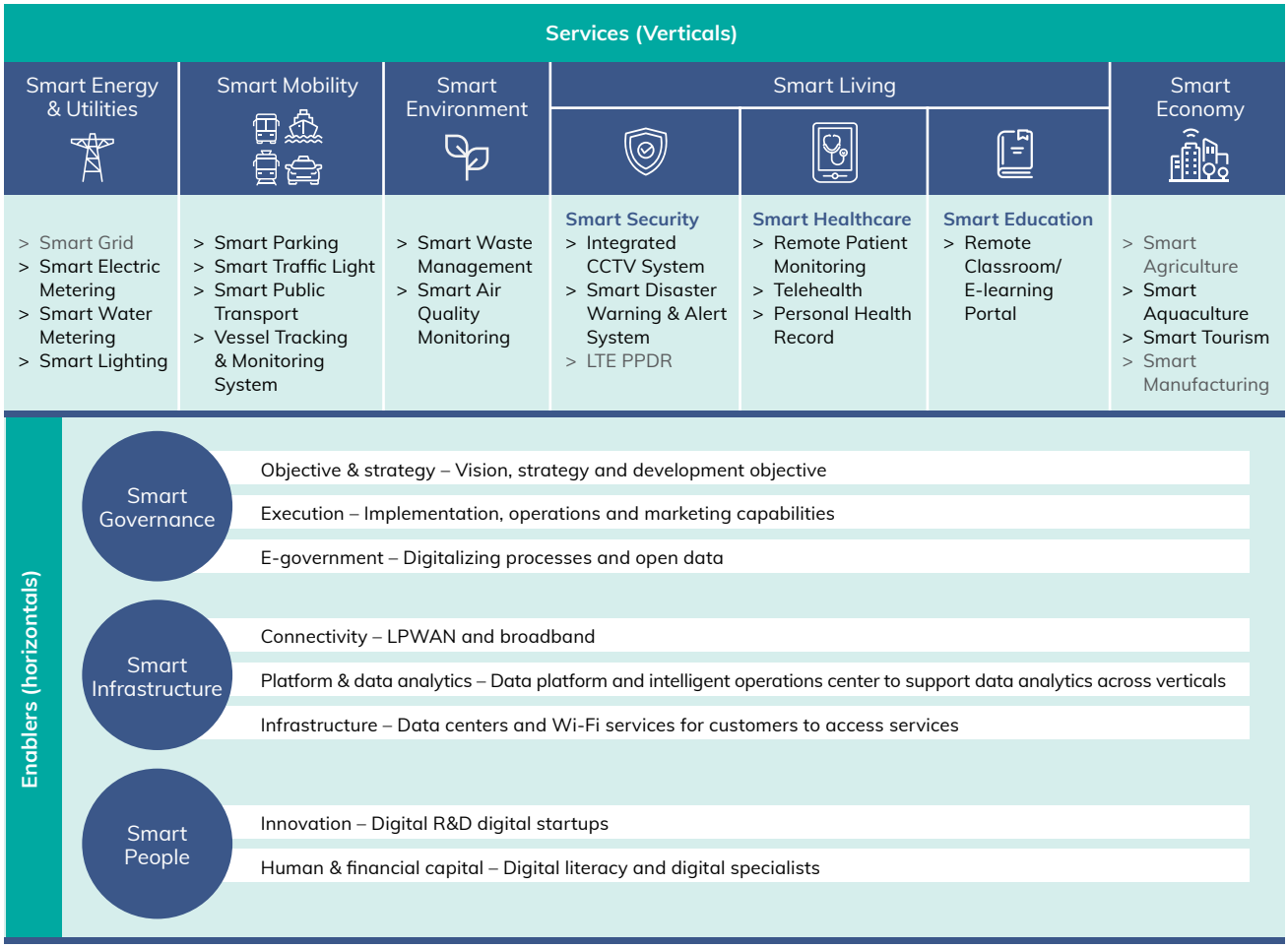
In the following part, we will show the assessment of selected case studies to understand the competency and readiness of each city across common key success factors.

	Relevant component – Descriptions	Vienna	Singapore	Seoul	Hong Kong
Strategy	> **Service Enabler** Solid strategy development increases the success potential of Smart City launch	> Clear strategic roadmap for 38 precisely defined strategic objectives until 2050 > Initial outlining of key pain points and structuring of initiatives done by experts, city administration and external partners	> Clear definition of 3 key strategic pillars, including Digital Economy, Digital Government and Digital Society > Strategy developed through close collaboration and benchmarking of future digital needs	> Plan focusing on specific issues as proposed in the guidelines for urban master plans and customized characteristics of the city > Clear plan setup with 17 indices, 17 goals and 60 strategies until 2030	> Clear vision to embrace innovation and technology to build a world-famed Smart Hong Kong > Development plan has been planned based on comprehensive study of 6 major areas of the city
Governance	> **Service Enabler** Operational capabilities support the project execution and ongoing operations of the service	> Urban Innovation Vienna is jointly promoted by the private sector and city administration > The setup of the independent agency enables close monitoring of implementation progress and results	> "Smart Nation and Digital Government Office" was erected to monitor progress of key initiatives and ensure timely execution of key milestones > No direct private involvement – To be determined on a by-initiative process	> Main authority to establish and approve the plan lies with the mayor of Seoul who adjusts the plan according to city characteristics > Plan's feasibility to be reviewed and improved by the mayor of Seoul every 5 years	> Steering committee on innovation and technology has been established to drive the Smart City development > Smart City office has been set up to coordinate between government departments and both public and private agencies
Infrastructure	> **Service Enabler** Readiness of infrastructure allows the service to be launched quickly and at full potential	> Strong connectivity and IoT ecosystem to support the launch of Smart City services > Digital readiness and penetration rate of digitalization are nearly at its full potential	> Digital Readiness Blueprint is in place to ensure that all key enablers are developed to allow digital access for the public > Developed connectivity, IoT systems and other key enablers have been ranked as top in the region	> Over 90% of Seoul's population use smart devices which are required to access full capacity and potential of various Smart City initiatives	> First class telecommunication network – One of the highest broadband speeds and penetration rates in the world > Dedicated test bed areas for Smart City solutions
Stakeholders support	> **Service Enabler** Supports from both private and public parties enhance the successful launch of Smart City services	> Strong support from both government and private sectors to enhance wellbeing and enable rapid economic growth > Full alignment on potential impact of initiatives on pain points	> Limited attention to the input of citizens, although the initiatives are focused on improving living conditions > Funding from the government for initiatives has been substantial	> Plan supported, formulated and developed based on city issues workshops with all departments > Citizens, experts and other interested parties selected to provide city-specific opinions and inputs	> Implementation model includes collaboration among public and, private sectors, academia and citizens have been considered as key focus for each individual Smart City initiative

1) Smart City Ranking is based on Smart City index developed by Roland Berger; RB has selected 87 long-list cities that involves in SC development for analysis

Smart City Framework Output

Based on the mixture of sources, we have formulated our Smart City framework into 5 key service verticals with 8 common key enablers as shown below:



Service Vertical Descriptions

Our Smart City framework consists of 21 services across 5 service verticals that can support the Smart City development at provincial and national level for Thailand. However, not all above services will be relevant for dry run in Phuket.

We have excluded 4 services at the beginning as we believe it is not possible for dry-run in Phuket:

- **Smart Grid** – The service is excluded due to the centralized responsibility of the service stakeholder. The launch of the service will require the permission of EGAT and PEA at the regional level rather than PEA at provincial level
- **LTE PPDR** – The launch of the service requires permission and authorized permit from the Royal Thai Police to support the launch as personal knowledge and training on LTE PPDR equipment needed
- **Smart Agriculture** – This service is not relevant to Phuket as agriculture business has a small scale compared to tourism and aquaculture businesses in Phuket
- **Smart Manufacturing** – Industrial factories are not widely available in Phuket, leading to low service relevance – This service is more relevant to provinces with large number of factories or industrial estates such as EEC provinces

Another 17 services covered in our framework have high potential to address as-is issues and increase competitiveness of overall Phuket. The prioritization and service recommendation will be available in Chapter 3 and 4.

The following part of the chapter is the detailed descriptions of the service verticals.

Smart Energy & Utilities

- **Smart Electric/Water Metering** – Electronic devices that record consumption of electric energy or water consumption in intervals and transmit that information to the utility companies for monitoring and billing
- **Smart Lighting –** Lights that are installed with sensors that are able to automatically turn on or off as required and inform

Smart Mobility

- **Smart Parking –** Optimized parking space usage and platform providing real time information on parking availabilities
- **Smart Traffic Light –** Improvement of traffic flow by enabling transportation choices through IoT mobility solutions
- **Smart Public Transport –** Provision of real time schedule of public transport units through tracking systems to enable journey planning by commuters
- **Vessel Tracking & Monitoring System –** Provision of real time location of vessels, allowing in-advance schedule planning for tourists as well as enhancing safety for vessels

Smart Environment

- **Smart Waste Management –** Optimized waste separation, collection and recycling to enhance operational efficiency
- **Smart Air Quality Monitoring –** Use of sensors to monitor ambient conditions and integrated systems to issue appropriate responses

Smart Living

Smart Security

- **Integrated CCTV system** – Interconnected security system of CCTVs and centralized command center for monitoring of "high-risk" locations to prevent crime and provide real time responses for public protection
- **Smart Disaster Warning & Alert System** – Utilization of environmental sensors to monitor and predict environmental changes for preemptive response for disaster relief

Smart Healthcare

- **Remote Patient Monitoring** – Monitoring of patients' conditions outside of conventional clinical settings, e.g., at home, to maintain independence of patients, prevent complications and minimize personal costs
- **Telehealth** – Long-distance clinical healthcare, e.g., connection between specialized doctors in large hospitals with health stations in remote areas, only staffed with nurses
- **Personal Health Record** – Integrated database that stores all information entered by patients to maintain and manage their health information in a private, secure and confidential environment

Smart Education

- **Remote Classroom/ E-learning Portal** – Long-distance education for educational institutions in remote areas to ensure that high-quality curriculum is applied across the province/city

Smart Economy

- **Smart Aquaculture** – Real time monitoring of water quality and feed timer system
- **Smart Tourism** – Emerging forms of ICT that allow city data to be transformed into value-adding services and functions for tourists

Service Enabler Descriptions

We have developed 8 key enablers to support the launch of Smart City services. As mentioned earlier in the chapter, service enabler is different from service vertical as the Smart City developer needs to develop and operates all enablers. The developer cannot just merely select which enabler they want to do.

Our developed enablers are aligned with the key success factors of the successful Smart City launch case studies to ensure the applicability and scalability of this project.

Below is the detailed description of service enablers by key success factor:

Smart Governance

- **Objective & strategy** – Involvement of public and private parties at city/province or national level to drive the masterplan development to address existing issues and enhance competitiveness of the city
- **Execution** – Ability to carry out the project implementation and ongoing operations with marketing capabilities to support the service scalability and achieve economy of scale
- **E-government** – Development of open data and digitalizing processes to support the service scalability and nationwide data accessibility

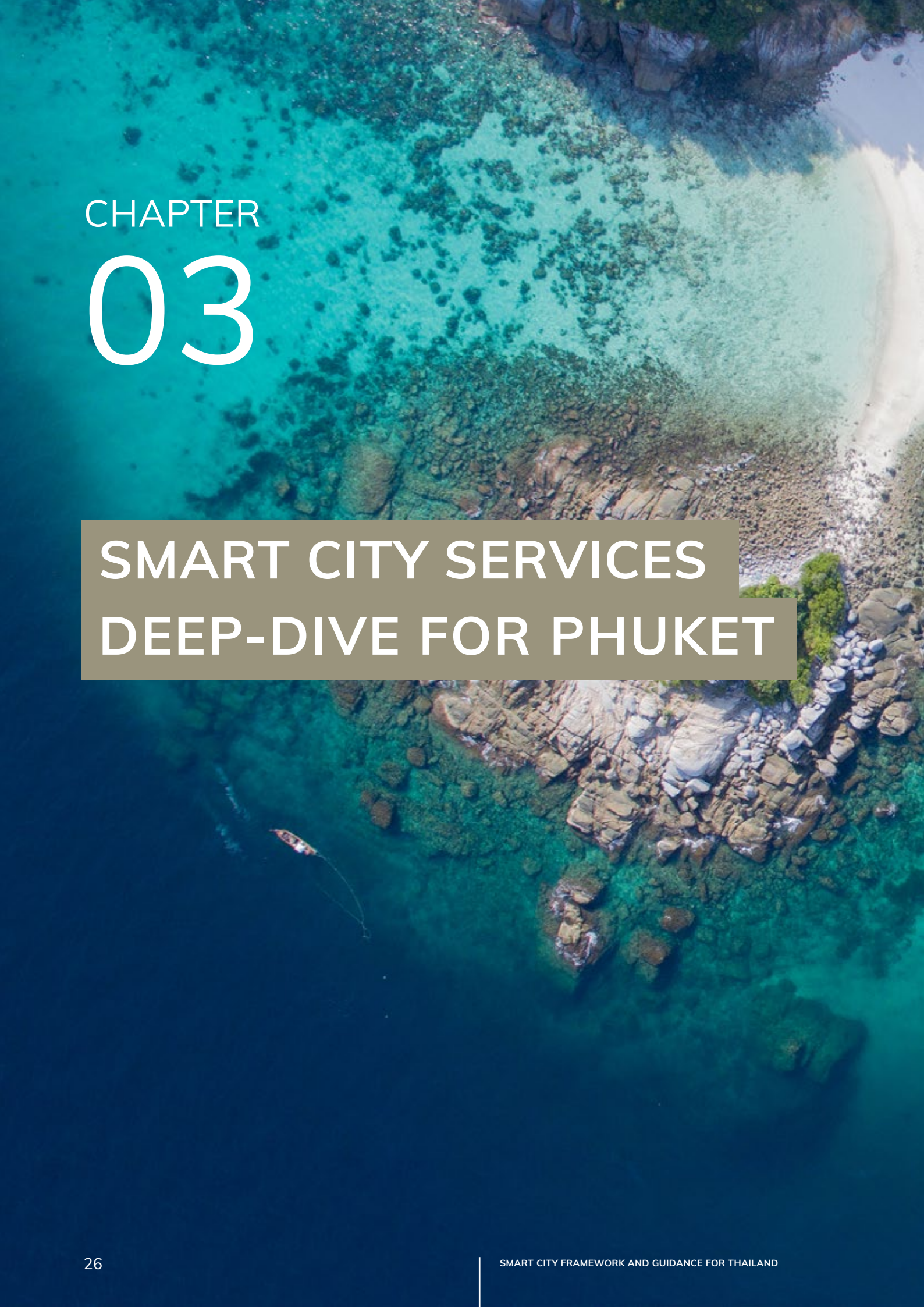
Smart Infrastructure

- **Connectivity** – Deployment of LPWAN, broadband, etc. to support the data transmission of sensors to support the Smart City ecosystem development and services scalability
- **Platform & data analytics** – Support for service operator in analyzing and collecting data across large numbers of deployed sensors to gain insights and further enhance competitiveness
- **Infrastructure** – Data center to support large data set collection and analytics

Smart People

- **Innovation** – Knowledge development and sharing across the Smart City and digital value chains to foster the growth of Smart City ecosystem
- **Human & financial capital** – Funding support to acquire resources and technology to support the launch

In the following chapters of this white paper, we will focus on shortlisting services and providing recommendations for the shortlisted services based on the current social and economic stance of Phuket, full potential market demand, planned and ongoing initiatives and results from stakeholder engagement to determine most feasible and beneficial services for Phuket.



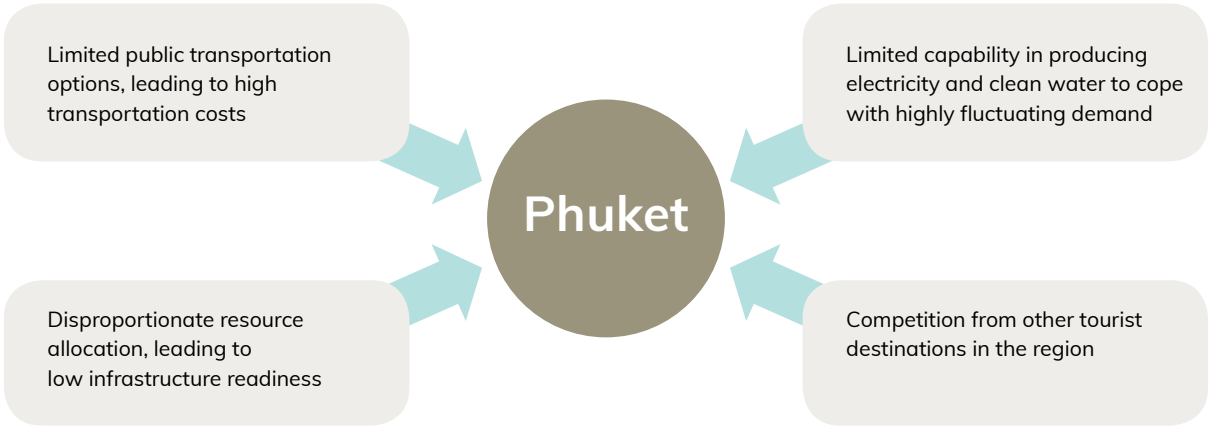
CHAPTER

03

SMART CITY SERVICES DEEP-DIVE FOR PHUKET

WE HAVE IDENTIFIED THE MAJOR PAIN POINTS IN PHUKET

Phuket is a small province, however, with an extremely high influx of visitors every year, the challenges faced by Phuket are therefore unique and should be addressed carefully. The schematic below summarizes the 4 key pain points of Phuket, which could potentially be addressed using smart city technologies.



Limited public transportation options, leading to high transportation costs

Transportation has long been a problem for Phuket, with beaches, attractions and the airport greatly dispersed from each other. Like many other cities in Thailand apart from the capital, Phuket has limited mass transit system, forcing locals and visitors to rely on cars; and with only one major backbone road across the island, traffic is inevitable during peak hours. Due to lack of options, taxis are also extremely expensive, making travelling around Phuket not very affordable. This has been a major problem, especially for foreigners, who are not aware of ways to get around the island other than relying solely on expensive taxi services.

Disproportionate resource allocation, leading to low infrastructure readiness

Many local entities and businesses have raised their concerns regarding the resource allocated to Phuket from the central government. This is because the number of registered residents in Phuket does not reflect the actual number of inhabitants and visitors. Moreover, Phuket as a province, contributes the 2nd highest GDP to the central government, and according to policy, Phuket will receive less allocated budget as it is deemed that the province requires less financial support. Without the budget, many public infrastructure cannot be upgraded or expanded to serve the ever increasing demands, for instance, waste collection facilities, safety equipment such as CCTVs and public transportation. More cost-effective and efficient systems will therefore need to be implemented to utilize the allocated budget as efficiently as possible through leveraging technology.

Limited capability in producing electricity and clean water to cope with highly fluctuating demand

As an island, Phuket has limited capability to produce it's own electricity or provide clean water; this is mainly due to spatial constraint and high cost of setting up the necessary facilities. Therefore, most of Phuket's electricity and water are procured from neighboring provinces and countries. With the fluctuating demand for these commodities during high tourist seasons, Phuket often experienced several power cuts every year and water shortages, causing damage, not only financially, but to the experience of visitors as well. It is therefore desirable to be able to monitor usage in order to predict and respond appropriately during peak seasons.

Competition from other tourist destinations in the region

Phuket is undoubtedly a popular tourist destination, with unique sceneries, beaches and attractions. Despite the industry's constant growth, many other destinations within the ASEAN region are gaining competitive edge in terms of affordability and serenity. Although currently not Phuket's biggest problem, local businesses and government should consistency improve convenience and satisfaction of tourists to maintain the contribution they have been enjoying from the industry. This includes various aspects of tourism for instance, security, convenience at airport and safety.

Smart City services will be selected "tailored specifically" to Phuket

Current strategy proposed by key stakeholders for Phuket Smart City

The major stakeholders shaping the strategy for smart city in Phuket are depa and PKCD. depa applies the national framework, focusing on six areas (Smart Economy, Smart Living, Smart People, Smart Governance, Smart Energy & Environment and Smart Mobility) to Phuket with a strong focus on promoting PPP, where the private party drives the initiative and the government provides regulatory support. PKCD, coming from the private sector, focuses on 4 key areas of Phuket Smart City for their masterplan (Smart Transit, Smart Tourism, Smart Energy and Smart City). These 2 stakeholders, one from the public and the other from private sector, are therefore spearheading the launch of smart city strategy in Phuket.

Having engaged with both stakeholders during the process of developing this white paper, it is clear that Phuket is a unique city, and requires specific "tailor-made" solutions. It is therefore, necessary to select the most appropriate solutions for Phuket.

We will first derive a long list of Smart City services and deep dive into each one

There are countless Smart City concepts being developed around the world. However, with practicality in mind, we will only consider the initiatives that have been proven to work in the long run and provide substantial benefit to the service operator or the society at large. Under the 7 verticals of Smart City areas defined in the earlier chapter, a number of Smart City initiatives have been selected for each vertical – **a total of 17 smart initiatives.** These initiatives are selected, primarily due to their proven benefit elsewhere in the world, and relevance to either tackling problems in Phuket or enhancing Phuket's strength. Each of the initiatives will be explored in depth, and assessed using a systematic and logical approach; the key areas we are deep-diving into for each initiatives are elaborated below.

i We will explain how each service work as well as their benefits

Firstly, we aim to establish a common understanding of how each service works and how they can benefit the city as a whole. Alongside step-by-step explanations, we have also included easy-to-understand schematics to explain how each service works and who are involved in the operation. This will provide a foundation to better understand how these can be applied to our specific scope of Phuket.

ii International case studies will provide the groundwork to how each service should be implemented

We have compiled international case studies for each smart initiative, which we believe Phuket can take inspiration from, or even directly adopt their operational model. Furthermore, these case studies will provide valuable information on the benefits they have generated elsewhere, the involved stakeholders as well as, where available, the size of investment.

iii Assessing relevance to Phuket is key to successful and sustainable implementations

Phuket is a unique city, having a small size and population, yet with a number of visitors many times its own people. For this reason, no solution from elsewhere can be directly copied and applied to Phuket; every smart initiative must be tailored specifically to Phuket's needs. Therefore, it is extremely important to assess the relevance of each Smart City with Phuket to ensure a successful launch, and that it addresses the problems or opportunities in Phuket.

iv Service readiness gives an indication of how easily the initiatives can be implemented

Before launching any Smart City services, it is crucial to consider the prerequisite requirements. This includes the existing infrastructure in the city, for instance internet coverage, and regulatory and legal barriers. A solid understanding of the readiness would help to establish an idea of the implementation feasibility for each services.

v We have identified on-going initiatives as well as stakeholders to interview

Although still at an early stage, there are currently a number of on-going smart initiatives in Thailand, specifically in Phuket. Most of them are still pilots, however, they may provide insightful lessons which means any future service provider will not have to start from scratch. We have also identified the stakeholders involved, many of whom we have interviewed to gain first-hand information and their recommendation on how to implement Smart City initiatives successfully.

This chapter will deep-dive into each of the 17 initiatives according to the structure established above. **Chapter 4** will synthesize the key information from the initiatives, and using a systematic prioritization matrix, recommend the Smart City initiatives which will most likely benefit Phuket as well as being sustainable in the long run.

Smart City services deep-dive

In this section, we have formulated deep-dive analysis to provide overview functions and benefits across 17 services. Moreover, we have further conducted the analysis specifically to Phuket to identify the relevance and readiness to support the service prioritization in Chapter 4 Below table is summary of our deep-dive Smart City services

SC Services	Functions – Benefits	Selected case studies	Relevance to Phuket	Initiatives
Smart Electric Metering	Real time energy transmission and consumption tracking – **Operator:** Optimal energy transmission, and operations cost saving **End-user:** Real-time consumption monitoring	Abu Dhabi, UAE Philadelphia, USA Dietikon, Switzerland	To potentially address high electricity consumption in Phuket as Phuket has high energy consumption per capita compared to national average and other key provinces	Not available
Smart Water Metering	Real time water transmission and consumption tracking – **Operator:** Operations cost saving, and leakage identification **End-user:** Real-time consumption monitoring	Dubai, UAE Gochang, South Korea Turin, Italy	To somewhat enhance the service offering by Provincial Waterworks Authority (PWA) & allow households to track level of water consumptions	Not available
Smart Lighting	Automatic light adjustment based on movements of surrounding areas – **Operator:** Predictive maintenance and operational cost saving **End-user:** Increase in safety for locals and tourists	Los Angeles, USA Bueno Aires, Argentina Paris, France	To upgrade as-is traditional street light bulbs in Phuket to reduce operations and maintenance costs and enhance bright areas across Phuket	● PKCD – MOU signed with NIDA tp develop solution
Smart Parking	Providing real-time information on parking space availability – **Operator:** Enhanced service offerings with potential add-on services for data analytics of the driving behavior **End-user:** Reduction of time spent in the parking lot	Wellington, New Zealand Düsseldorf, Germany Los Angeles, USA	To address as-is limited parking space in Phuket as Phuket has high number of vehicles per capita as compared to the national average	Not available
Smart Traffic Light	Automatic traffic light adjustment system based on current traffic conditions – **Operator:** Enhanced service offerings and cost savings from automatic system **End-user:** Reduction of travelling time and traffic congestion hours	Miami-Dade, USA Copenhagen, Denmark Milton Keynes, UK	To address as-is traffic congestion issues in Phuket as Phuket has high number of vehicles per capita as compared to the national average	● **Safer Road Foundation** – Operates across 5 intersections
Smart Public Transport	Real-time public transport schedule and availability – **Operator:** Increase in utilization of public transport **End-user:** Advanced schedule planning and increase in user convenience	Vienna, Austria Helsinki, Finland Dubai, UAE	To address as-is limited parking space in Phuket as Phuket has high number of vehicles per capita as compared to the national average	Not available

● Plan available but not yet launched ● On-going initiative

SC Services	Functions – Benefits	Selected case studies	Relevance to Phuket	Initiatives
Vessel Tracking	Providing real-time vessel tracking & monitoring – **Operator:** Increase in vessel management efficiency **End-user:** Advanced schedule planning and increase in safety from precision location detection	Jacksonville, USA Pittsburgh, USA Mexico (various gulf areas)	To enhance safety of marine transport for tourists and businesses as marine transport is essential for between islands transportation and aquaculture businesses	**depa** – Operates vessels along with AIS sys. for precision location tracking
Smart Waste Management	Waste level monitoring and pick up route planning – **Operator:** Increase in pick-up efficiency and operational cost saving **End-user:** Reduction of overfilling bin issues	Cascais, Portugal Philadelphia, USA Tampines & Pasir Ris, Singapore	To handle high volume of generated waste due to increase in population and visited tourists in Phuket; This solution can potentially address asis issues on large uncollected waste volume	**D-Kids** – Focuses on Patong area **Traffy** – Covers 30 km2 area **Moonfoi** – Provides monetary incentive
Smart Air Quality monitoring	Real time air quality measurement and tracking – **Operator:** Precision air quality monitoring **End-user:** Real-time access to air quality information	Paris, France Seoul, South Korea London, UK	Not relevant to as-is situation in Phuket, however, the solution can help Phuket prepare for growth in population and tourists which can cause pollution generated from large number of vehicles	**Municipality** – Installation of sensor at Health Center in Phuket
Integrated CCTV system	Real-time monitoring and instant alerts from the central operations center – **Operator:** Real time monitoring, instant alerts and cost saving from remote file retriveing **End-user:** Increase in safety	Anyang, South Korea Guaymas, Mexico Shenzhen, China	To support the police and other related officers to enhance safety for locals and tourists across areas in Phuket; No. of police officers to the provincial population in Phuket is still low as compared to the national average	**Hitachi** – Plans to install and integrate CCTVs in one command center
Smart Disaster Warning & Alert	Monitoring and predicting of environmental changes that lead to natural disasters – **Operator:** Real time monitoring, instant alerts and advanced mitigation plan **End-user:** Increase in safety for locals and tourists	Philippines (nationwide) Toshima, Japan Rio de Janeiro, Brazil	To allow officers to monitor and predict environmental changes in order to prepare for advanced mitigation plans as Phuket is somewhat prone to natural disasters such as tsunami, landslide and flooding	**depa** – Installation of 14 sensors across Bang Yai canal
Remote Patient Monitoring	Monitoring the condition of patients outside of conventional clinical settings – **Operator:** Operational cost reductions and instant alerts **End-user:** Reduction of travel time, and increase in healthcare access	Singapore, (Nationwide) Phoenix, USA NHS Highlands, Scotland (UK)	To provide remote healthcare services to people & elderlies in remote areas as currently around 10% of total Phuket population are aged over 60	**BDMS** – Collaboration with local/ small hospitals to enhance existing service offerings
Telehealth	Long-distance clinical health care through telecom. devices and technologies – **Operator:** Providing large service coverge to people in remote areas **End-user:** Reduction of travelling time and increase in healthcare access	Singapore, (Nationwide) Toshima, Japan Singapore, (Nationwide)	To increase healthcare service coverage to people in rural areas and enhance standardized healthcare process/ treatment across the Phuket	**MOPH** – Connecting system between public hospitals and remote small health centers

SC Services	Functions – Benefits	Selected case studies	Relevance to Phuket	Initiatives
Personal Health Record 	Integrated database that stores all patient information – **Operator:** Up-to-date treatment and critical info. **End-user:** Increase in conviniences due to shared and standardized info.	Denmark (Nationwide) Estonia (Nationwide) Australia (Nationwide)	To support the standardized patient information across and beyond Phuket and support a better quality and continuity of care in the province	● **MOPH** – Phuket selected as one of the pilot launch province
Remote Classroom 	Providing educational system remotely – **Operator:** Increase in education coverage **End-user:** Increase in access of standardized education sys.	Singapore, (Nationwide) Ermelo South Africa	To improve access of high quality education to students in remote areas as Phuket currently has around 20,000 of young people that have no access to education	● **Chulalongkorn Uni.** – Remote class room by leveraging material from MIT
Smart Aquaculture 	Water condition monitoring and feed management – **Operator:** Reduction of human labor costs **End-user:** High quality fishery products available	Taiwan (Nationwide) Japan (Nationwide) California, USA	To improve farming process of both fishing by vessels in deep sea area and fish farms located near the coastal areas of Phuket; Moreover, the service can be leveraged by high value farming to provide good water condition & environment to their fishery products	Not available
Smart Tourism 	Enhancing tourist experience and safety – **Operator:** Leveraging collected data to cater existing local services to suit tourist characteristic and needs **End-user:** High quality services experienced in Phuket	Helsinki, Finland Antwerp, Belgium	To enhance tourists' experience in Phuket by providing specific/ catered services to their needs; As Phuket has high number of visited tourists, this service can support the growth of economy and provide sustainable tourism industry for Phuket	● **Phuket Patri Tour** – Wristband services that cover both land and ● **Flowlow** – Wristband that in collaboration with hospitals marine area

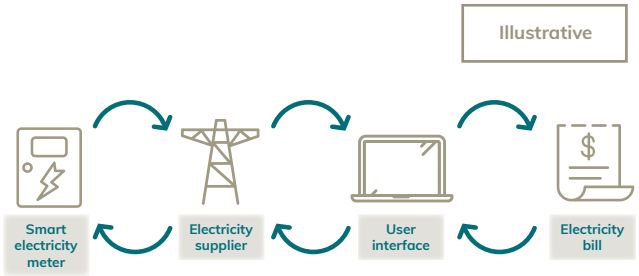
● Plan available but not yet launched ● On-going initiative

SMART ELECTRICITY METERING

Service Overview

Function – Smart Electricity Metering involves the implementation of electronic devices along with advanced analytics to monitor and record real time electricity consumptions and communicate the actual information to the electricity supplier. This is done with an aim of forecasting electricity expenses and obtaining more accurate electricity bills. The system allows two- way communication between the meter and the supplier so that information provided to users are both real time and transparent.

Smart Electricity Metering works in a simple manner. Firstly, installed smart meter measures and records electricity usage typically once every 30 minutes or an hour. The recorded information on actual electricity consumption is then automatically and wirelessly transmitted to the electricity supplier for further monitoring. The system leverages a secure national communication network during the process. Electricity supplier then makes the consumption information available to users via user interface such as web portals, mobile application or in-home displays. Users can now constantly monitor their consumption, forecast their expenses and manage their utilities expenses.



Benefit – Smart Electricity Metering will provide benefits to both residents and also electricity suppliers. Residents will no longer need to remember and manually provide meter readings to the supplier. They will be able to monitor real time electricity consumption directly so that electricity bill can be better managed and controlled. Moreover, smart meter will be able to provide real time alerts to the supplier in case if there is a likelihood of outage. This will allow supplier to react with proper measures in a timely and cost effective manner before actual outage occurs and hence, reduce customer expenses.

On the other hand, electricity supplier will be able to achieve cost savings as electricity consumption can be recorded remotely without having to travel to customer sites. The supplier will also be able to track the meter performance and immediately replace as needed instead of conducting regular check up with customers, hence reducing their costs.

Global Case Studies

The three examples below illustrate successful case studies for Smart Electricity Metering which have been launched around the world. The common observed benefits of these case studies are higher service reliability, cost saving through improved operational efficiency and improved customer experience.

Generally, Smart Electricity Metering service is operated by public party who leverages technological insights/ knowhow, as well as both software and hardware provided by technology companies. They are usually involved at the beginning of solution development such as device setup/ integration, infrastructure development and device trial/ testing. All of these technology companies are however not involved with daily electricity supply management and operations.

Case study 1: Abu Dhabi, UAE

Status & scale:
- Implemented in 2010
- Implementation covering over 200,000 commercial and residential facilities

Service overview
- Provide holistic view of energy consumption in the city through the use of cloud-based solution, enabling the identification, prioritization, tracking and execution of energy efficiency strategies/ projects
- Enable the city to strategically manage and optimize their energy and natural resource usage

Expected/ realized benefits
- Expected peak demand **reduction of 4 GW** by 2020
- Projected total annual energy **savings of 12,000** GWh by 2020
- **Reduction of ~10 million tons** of carbon dioxide

Relevant stakeholders

Hara (private)
- Provides end-to-end solution

Abu Dhabi Water and Electricity Authority (public)
- Operates electricity supply and management

XXX = Service operator

Case study 2: Philadelphia, USA

Status & scale:
- Implemented in 2010
- Over 180,000 smart meters as well as meter data management system installed, covering 1.6 million electric customers across the Greater Philadelphia area

Service overview
- Allow customers to monitor their electricity consumption, ushering in hourly dynamic rates that incentivizes users to shift load to off-peak hours, resulting in efficient resource management
- Provide distribution system that automatically detect any possible faults and reroute electricity to minimize power disruptions
- Detect both tampering by customers or overheating through the use of smart meters which also send out alarms to alert officials

Expected/ realized benefits
- Power restoration time **reduced by 1 day**, following massive storm
- Service restored **2-3 days more quickly**, following massive ice storm
- **105,000 vehicle trips avoided** due to ability to connect/ disconnect customers remotely

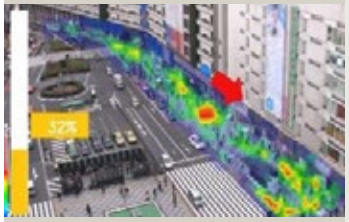
Relevant stakeholders

PECO (private)
- Provides end-to-end solution

Pennsylvania Public Utility Commission (public)
- Operates electricity supply and management

XXX = Service operator

Case study 3: Dietikon, Switzerland



Status & scale:
- Implemented in 2010
- 1,000 smart metering points delivered with fully integrated PLC based communication technology supported by Meter Data Unification and Synchronization (MDUS) software

Service overview
- Provide real time energy consumption monitoring for end users, with tariff data displayed on in-home user interface solution
- Support interval consumption data collection, outage management and two-way communication with metering devices

Expected/ realized benefits
- On demand meter readings conducted **within 2 minutes,** while regular readings **within only 3 seconds**
- **80-99% increase** in overall Meter Data Management (MDM) efficiency
- Daily updates of electricity consumption data conducted down to **collection interval of 15 minutes**

Relevant stakeholders

Landis+Gyr (private)
- Provides end-to-end solution

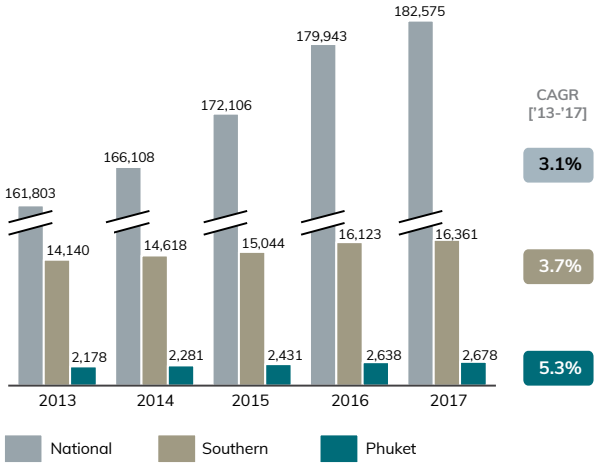
Elektrizitätswerke Des Kantons Zürich (EKZ) (public)
- Operates electricity supply and management and implements solution

XXX = Service operator

Service Relevance to Phuket

Smart Electricity Metering is relevant for city/ province that has high level of electricity consumption or high number of reported power outage cases. The solution is expected to provide consumption visibility for residents so that they could better manage and control their monthly electricity consumption.

The demand for Smart Electricity Metering service is driven by how much electricity is generally consumed within the city/ province. This can be proxied by both the total actual consumption as well as the total number of customers. The higher the number of these factors, the more relevant and higher potential for this service to support both local residents and suppliers in Phuket.



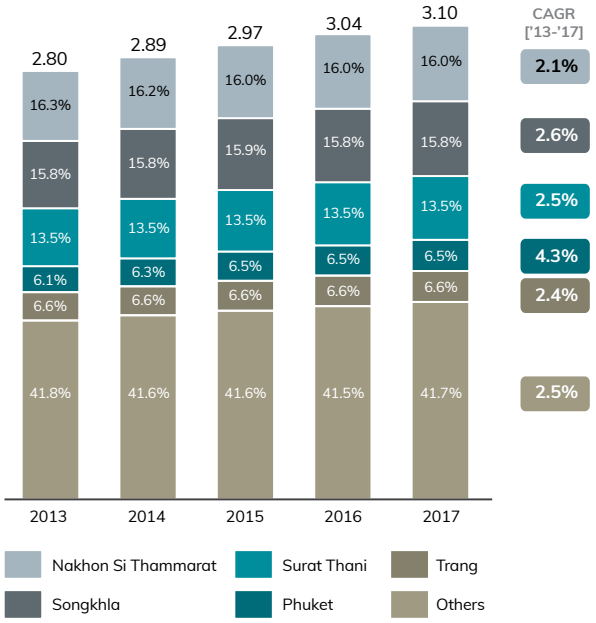
Source: Metropolitan Electricity Authority, Provincial Electricity Authority

Annual electricity consumption in Phuket has been gradually increasing within the past years, following similar trend as annual electricity consumption for both national and Southern region. The total consumption in Phuket amounts to 2,678 GWh in 2017 which is considered to be approximately 16% of the total of Southern region. It has also been shown that the growth rate of annual electricity consumption in Phuket is stronger than those of national and Southern region. Phuket has experienced consumption increase with CAGR of 5.3% between 2013-2017, while for national and Southern region, CAGR are 3.1% and 3.7% respectively within the same period.

The total consumption in Phuket amounts to 2,678 GWh in 2017 which is considered to be approximately

16%

of the total of Southern region.



Source: Metropolitan Electricity Authority, Provincial Electricity Authority

In terms of total number of customers, Phuket has 202,977 electricity customers in 2017. This figure is the fourth highest among all the provinces in the Southern region and is also accounted for approximately 6.5% of the total electricity customers within the region. Furthermore, it is also shown that, when compared to other provinces in the region, Phuket has the highest growth in total electricity customers between 2013-2017. Within this period, Phuket has experienced an increase with CAGR of 4.3%, roughly twice the CAGR for other provinces.

Furthermore, Phuket experiences blackouts every year due to shortages of electricity imported from neighboring provinces/ countries during high season. Smart Electric Metering will also allow authorities to view the overall electricity consumption and prepare counter-measures beforehand to prevent any blackouts.

We also believe that the demand for Smart Electricity Metering will grow at a faster rate in later years due to the successful pilot launch which will exhibit many realized benefits to the province as a whole and hence receive an increasing amount of support from both public and private parties, resulting in both smoother implementation and operational processes.

Service Readiness

We established the requisite infrastructure and regulations to determine readiness for a particular type rvice. Requisite infrastructure and regulation refer to necessary equipment and/ or access for setting up the service in Phuket.

We believe that successful Smart Electricity Metering deployment relies heavily on strong network of internet to ensure stable connections so that the two-way communication between smart meter and supplier could be as real time as possible. This is crucial for Smart Electricity Metering since the more accurate the information, the more accurate the monitoring process as well as the electricity bill would be.

Based on the current situation in Phuket, it is possible to launch Smart Electricity Metering service as Wi-Fi points are currently available throughout the city, with the local government also granting a significant amount of budget to support the installation of at least 1,000 additional Wi-Fi points throughout the city.

Electricity accessibility should also be considered before launching the service. This is because the higher the number of households with access to electricity and with electricity meter already equipped, the easier the meter upgrade and the launch of the service will be.

From the assessment, electricity is currently fully accessible from everywhere in Phuket. Therefore, Smart Electricity Metering service can potentially be launched in urban areas, due to the high concentration of households, to initially test for the service feasibility before launching at full province scale.

Other than infrastructure, we have also analyzed current regulations to understand whether this solution complies with current regulation or not as well as to determine the feasibility of the service. Currently, there is no regulation that will limit the launch of this service. Electricity is currently distributed in Phuket by Provincial Electricity Authority. Hence, the solution provider will need to obtain licenses and approvals from their regional office before installing new smart electricity meters and replacing/ modifying any related existing infrastructure owned by the government. The solution provider must follow the regulation/ guidelines formulated by both national and local governments as well as current authorized electricity suppliers.

Key Stakeholders

Stakeholders for service set up and/ or operations – Public and private parties that will be involved in the setting up and deployment of Smart Electricity Metering

	Electricity generation	Electricity transmission	Electricity distribution & bills collection	Meter installation & maintenance
Descriptions	> Generate national electricity supply > Purchase power from other power producers and other countries	> Transmit generated electricity from producers to substations for further distribution	> Distribute transmitted electricity to all households > Collect payment for electricity bills from customers	> Install and/ or upgrade smart electricity meter > Perform regular check ups > Repair and/ or replace any necessary devices
Stakeholders	Electricity Generating Authority of Thailand (EGAT) Various independent power producers (IPPs)		Provincial Electricity Authority (PEA)	Solution provider

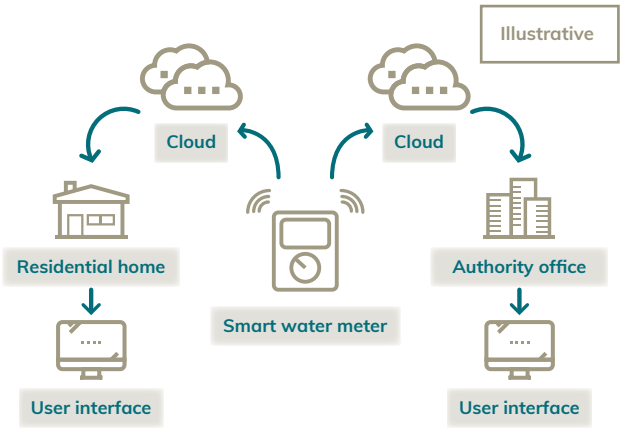
Planned & Ongoing Initiatives

There are no planned & ongoing initiatives on Smart Electricity Metering in Phuket

SMART WATER METERING

Service Overview

Function – Smart Water Metering provides real time water consumptions along with analytics to forecast the utilities expenses. The real time data from Smart Water Metering can be monitored from both web and mobile applications. This solution requires the cellular network or direct connection with broadband to transmit data from and to waterworks authorities and households



Benefit – Smart Water Metering will provide benefits to both residents and also waterworks authorities:

- **Residents** – Residents will be able to see real time water consumption directly from their mobile phone or computer to plan the utilities expense for the rest of the month. Moreover, it can potentially help identify water leakage if the water consumption is anomaly high as compared to previous month consumptions.
- **Waterworks authoritie** – Waterworks authorities can experience cost saving from the solution as it allows the officers to remotely record water consumption from their operations center. Moreover, waterworks authorities can also track the meter performance and replace battery when needed.

The solution has successfully been implemented globally. Below three global case studies demonstrate solution overview and realized/ expected benefits from this solution

Global Case Studies

We have selected three cases studies that have shown the successful launch of the Smart Water Metering with tangible realized benefits few years after the implementation. Throughout below case studies, the solution is typically paid and operated by a public party to reduce the operational costs of metermen deployment, enhance experience for end users and enhance service offering by identifying unusual water consumptions.

The solution developers are generally private parties, they usually involve at the beginning of the solution development such as smart meter setup and integration, infrastructure development and trial run support. All of the solution developers are not involved with day-to-day water supply management and operations.

The common benefits that three case studies have realized are reduced operations costs from metermen deployment, identification of water leakages from unusual consumption alerts and water consumption planning for users. Below three cases have been selected as they are varied in terms of economic background, geography and demographic status, but they all share similar proven/ tangible benefits in both short and long terms after the implementation.

Case study 1: Dubai, UAE

Status & scale:
- Implemented in 2018
- Over 595,000 meters installed, equivalent to 80% of total water metering in UAE

Service overview
- Provide real time water consumption with monthly water consumption projection feature
- Send alerts for unusual consumption patterns to both users and waterworks authorities

Expected/ realized benefits
- **20,000 cases** of water leakage, **4,700 faults and 1,400 cases** of extra-load identified
- Total **savings of ~AED 52.6 million**
- Expected increase in consumption visibility and improved utilities spending planning on a monthly basis

Relevant stakeholders

Honeywell (private)
- Provides device and solutions to waterworks authority

DEWA (public)
- Operates water supply and management

Whizkey (private)
- Provides AI solution supporting distribution system

XXX = Service operator

Case study 2: Gochang, South Korea

Status & scale:
- Implemented in 2017
- Sensors installed in over 24,000 households, with over USD 5 million of investment

Service overview
- Provide water meter recording from remote area which leads to higher operational efficiency of waterworks authority
- Allow the service operator and residents to access real time consumption from mobile phone and PC

Expected/ realized benefits
- Annual **cost reduction of 19%** stemming from water leakages
- Reduced number of monthly household visits by metermen due to remote monitoring process
- Increased safety for residents if unusual consumption is identified

Relevant stakeholders

Freestyle Technology (private)
- Provides device and end-to-end solution

Gochang Municipality (public)
- Operates water supply and management

XXX = Service operator

Case study 3: Turin, Italy

Status & scale:
- Implemented in 2017
- Planned service coverage extension to other cities by 2020

Service overview
- Provide real time water consumption with consumption projection feature
- Send alerts for unusual consumption patterns and allow waterworks authority to remotely track consumption

Expected/ realized benefits
- Ability to monitor water consumption in real time by end users
- Ability to easily track water consumption by water supply companies
- Reduced costs from watermen deployment in remote areas for meter recording

Relevant stakeholders

Huawei (private)
- Provides device for the solution

SMAT (public)
- Operates water supply and management

TIM Group (private)
- Provides connectivity

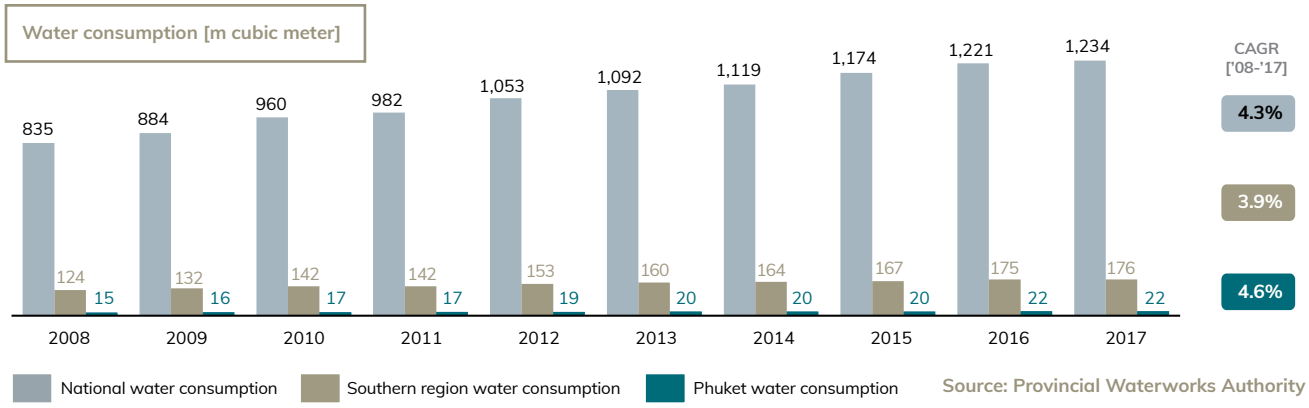
Olivetti (private)
- Provides capital and knowledge transfer

XXX = Service operator

Service Relevance to Phuket

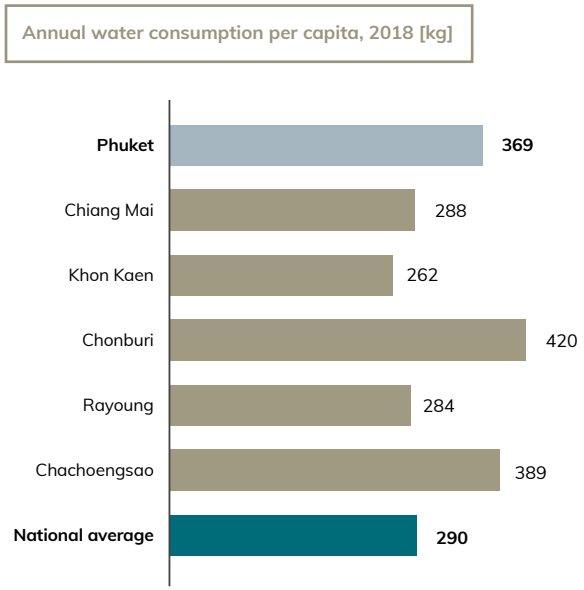
Smart Water Metering is relevant for city/ province that has high level of water consumption or high number of reported water leakage cases. The solution is expected to provide consumption visibility for residents which they can better manage or limit their water consumption.

Smart Water Management solution has high potential to support local residents in Phuket by monitoring their water consumption as water consumption in Phuket has increased by around 4.6% between 2008 and 2017 as compared to 4.3% and 3.9% of the national and regional figures respectively within the same period.



Source: Provincial Waterworks Authority

The previous graph has shown that the growth of water consumption in Phuket has grown at a stronger rate than national average and other provinces in Southern region. Below graph is the comparison of water consumption per capita between Phuket, major provinces and national average.



Source: Phuket NSO, Provincial Waterworks Authority

Water consumption per capita of Phuket is higher than majority of key provinces and national average. Based on the current situation in Phuket, we believe that Smart Water Metering has strong potential to play important roles in supporting Phuket waterworks authority on cost reduction and residents to better manage water usage throughout the month.

We have formulated bottom-up market sizing to determine **full potential demand of number of installed smart meters** across Phuket to help prioritize service for dry run and determine the attractiveness of this service in the long run. Based on current demographic and situation, Phuket has full potential to turn ~9,000 of existing water meters to support Smart Water Metering solution. Our bottom-up market sizing has been formulated based on **facts gathered** from public authorities such as water consumption, number of households, percentage of water usage and penetration of improved sanitation facility, and **assumptions** such as meter per household and adoption rate of Smart Water Metering solution.

Number of full potential demand was mainly derived from following items:

- Consumption Multiplier (mainly facts based) – Calculated based on water consumed in Phuket as compared to the national average to understand urgent needs of the service
- Adoption rate of Smart Water Metering solution – Benchmarked with global case studies to identify the current addressable market of Smart Water Metering

We believe that number of installed smart meters will grow faster in later years due to the successful proof-of-concept launch, lower price of the device/ solution offering, realized benefits from the solutions and increased support from both public and private parties.

The total consumption in Phuket Phuket has full potential to turn ~9,000 of existing water meters to support Smart Water Metering solution.

Service Readiness

We have assessed the required infrastructure and regulations to determine the readiness of Phuket to launch Smart Water Metering service.

We believe that there are two key fundamental infrastructures required to support the successful launch of the service:

- Water accessibility – To help assess if majority of households have access to water source with installed water meters or not
- Smart phone penetration – To help understand if locals in Phuket can leverage the full potential of the solution in order to manage water consumption remotely or not

From the assessment, majority of people in Phuket has access to improved water sources. Moreover, the smart phone penetration rate in Phuket is projected to be around 50%. Based on above information, Smart Water Metering can potentially be launched at a selected sub district or area to test the service feasibility with strong potential to launch at full province level later.

Other than infrastructure, we have also analyzed current regulations to understand whether this solution complies with current regulation or not as well as to determine the feasibility of the service. Currently, there is no regulation that will limit the launch of this service. Water supply in general is managed and supplied by Provincial Waterworks Authority in the province and the waterworks division of local municipalities. In case that the solution provider needs to install new smart meters or replace water meters on existing infrastructure, they are required to obtain licenses and approvals from local relevant stakeholders prior to modifying government assets. The solution provider must follow the regulation/ guidelines formulated by national and local governments and current authorized water suppliers.

> *"Our existing offering allows us to monitor and identify water leakages, however, Smart Water Metering will further allow us to remotely record water consumptions of households in remote areas which can provide cost saving to PWA"*
>
> Chief - Provincial Waterworks Authority (PWA) (Phuket Regional Office)

Key Stakeholders

Stakeholders for service set up and/ or operations – Public authorities that set up water supply infrastructure and provide water management and operations. Below figure shows the value chain of water supply and management in Phuket.

	Water procurement	Water distribution	Meter installation & inspection	Water meter collection
Descriptions	> Develop infrastructure to procure water from clean and qualified water source > Lay out waterpipe connecting households to water source	> Plan water distribution in the province > Allocate responsibilities of water distribution between public agencies	> Install water meter at responsible areas > Replace battery and provide maintenance of water meter if needed	> Deploy metermen to collect and record meter readings in varied areas to update on the monthly water consumption
Stakeholders	Provincial Waterworks Authority (PWA) (Phuket Regional Office) Phuket City Municipality (Waterworks Division)			

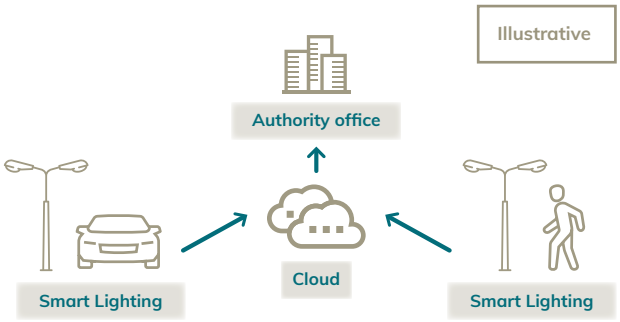
Planned & Ongoing Initiatives

There are no planned & ongoing initiatives on Smart Water Metering in Phuket

SMART LIGHTING

Service Overview

Function – Smart Lighting measures and tracks real time traffic flows and people in the surrounding areas. The collected data allows the lighting operator to automatically adjust or dim the light in order to optimize the electricity consumption. Moreover, some of Smart Lighting solutions have sensors attached to the lamp post which can help analyze traffic flow for better traffic management.



Benefit – Smart Lighting will provide benefits to both residents and the street light operators:

- **Residents** – Residents will be able to walk on the street safely. Large coverage of bright area can potentially reduce urban crime rates. Moreover, drivers will experience less traffic congestion as real time traffic information will be sent to integration system of Smart Lighting and traffic light management for real time adjustments.
- **Street light operators** – Operators will experience cost saving from optimal energy supply as the solution will help adjust brightness of light bulbs based on movements and traffic flow from surrounding areas. Additionally, operators can remotely track light bulb performance and provide maintenance when needed.

Global Case Studies

We have selected three cases studies that have shown the successful launch of the Smart Lighting solution with tangible realized benefits few years after the implementation. Throughout below case studies, the solution is typically paid and operated by a public party. The solution is expected by the operator to provide the energy saving from real time movement tracking of surrounding environment which allows the operator to automatically manage the lighting schedule. Moreover, the solution allows the operator to formulate predictive maintenance schedule on light bulbs to better plan resource allocation. At the city level, the solution can enhance safety due to larger coverage of bright areas.

The solution developers are generally private parties and usually involve at the beginning of the solution development such as light solution integration, infrastructure development and trial run support. All of the solution developers are not involved with day-to-day lighting management and operations.

The common benefits that three case studies have realized are cost saving on operations and maintenance, energy saving, safety enhancement, crime rate reduction, optimal traffic management and predictive maintenance feature. Below three cases have been selected as they are varied in terms of economic background, geography and demography, but they all share similar proven/ tangible benefits in both short and long terms after the implementation.

Case study 1: Los Angeles, USA

Status & scale:
- Implemented in 2017
- 50,000 LED lighting system installed, with over USD 14 million of investment

Service overview
- Provide real time measurement and tracking of surrounding environment to optimize electricity supply
- Measure traffic flows to help traffic light authorities adjust traffic light accordingly

Expected/ realized benefits
- Annual **saving of USD 8 million or 60% cost reduction**
- Realized energy saving and automatic LED light adjustment based on gathered surrounding information
- Reduced crime rates due to bright areas throughout the city along with CCTVs and sensors attached on light poles

Relevant stakeholders
Philips Lighting (private) - Provides device and solutions to the lighting authority

Bureau of Street Light (public) - Sets up, operates and maintains light bulbs and lighting system

XXX = Service operator

Case study 2: Buenos Aires, Argentina

Status & scale:
- Implemented in 2016
- 125,000 of existing lighting (~75% of total) replaced with Smart Lighting solution

Service overview
- Install real time traffic flow monitoring to collect traffic flow data on the street which can be transmitted to the traffic light authorities later
- Provide real time information of light bulb performance for the operator to plan maintenance schedule

Expected/ realized benefits
- Realized energy **saving of over 50%** for the whole city consumption
- Reduced annual carbon dioxide emissions
- Reduced maintenance costs due to extended life span
- Minimized crime rate and reduced traffic by analyzing traffic flow from attached sensors

Relevant stakeholders
Philips Lighting (private) - Provides device and solutions to the lighting authority

Buenos Aires Authority (public) - Sets up, operates and maintains light bulbs and lighting system

XXX = Service operator

Case study 3: Paris, France

Status & scale:
- Implemented in 2016
- Planned budget of ~USD 600 million (no exact figure on actual spending)

Service overview
- Provide predictive maintenance on light bulb feature for the operator
- Measure traffic flow to help the traffic light authorities adjust traffic light accordingly

Expected/ realized benefits
- Expected **30% increase** in city's energy saving between 2004 and 2020
- Expected **reduction of payback period** of the investment to as little as **6 years**
- Expected **50% reduction** of operational costs

Relevant stakeholders
Silver Spring Network (private) - Provides device and Smart Lighting solution platform

EVESA (public) - Sets up, operates and maintains light bulbs and lighting system

XXX = Service operator

Service Relevance to Phuket

Smart Lighting solution is relevant for city/ province that has high operations and maintenance costs of street lights, high level of electricity consumption, traffic congestion and high number of reported crime cases. Smart Lighting has varied solutions which can provide benefits to both the street light operators and local citizens/ tourists.

Majority of street lights in Phuket are traditional light bulbs which have higher maintenance cost than LED light bulbs. Moreover, the life span of traditional light bulb is expected to be five time shorter than LED light. Some government agencies in Phuket has recognized this issue and they are working to address this problem, for example, Phuket Provincial Electricity Authority (PEA) has worked with Chulalongkorn University to conduct feasibility of upgrading traditional lights to LED lights.

To determine the potential full demand of the solution in Phuket, we have formulated bottom-up market sizing to determine **number of installed Smart Lighting** across Phuket to help prioritize service for dry run and determine the attractiveness of this service in the long run.

Based on current situation and geography, Phuket has full potential to turn ~1,500 of street lighting points to support Smart Lighting solution. Our bottom-up market sizing has been formulated based on **facts gathered** from public authorities; and **assumptions** such as distance between lamp posts, number of light bulbs on each lamp post and adoption rate of Smart Lighting solution.

Number of full potential demand was mainly derived from following items:

- Phuket street length (facts and assumption based) – Calculated based on Phuket provincial and city size with street multiplier which varied across provincial and city level
- Distance between each lamp post (assumption based) – Benchmarked with typical road and light system development at national level
- Adoption rate of Smart Lighting solution (assumption based) – Benchmarked with global case studies to identify the current addressable market of Smart Lighting

We believe that number of installed Smart Lighting will continuously grow in the future. Three drivers that can potentially impact the growth of solution are:

- Expansion of street lights coverage – The expansion of lighting coverage can drive the adoption of new technology as currently the cost of LED lighting/ Smart Lighting solution is less expensive than in the past. Thus, the expansion can potentially support the growth of Smart Lighting solution
- Initiatives by local authorities to improve energy usage and consumption – Local governments are collaborating with other stakeholders to increase overall lighting situation in Phuket
- High operations and maintenance costs from existing street light – High cost from operations can potentially increase the adoption of Smart Lighting solution. Currently, Phuket is somewhat facing high operations and maintenance cost due to majority of light bulbs are non LED lighting which can result in shorter life span and frequent maintenance requirements.

Service Readiness

We have assessed the required infrastructure and regulations to determine the readiness of Phuket to launch Lighting solution.

We believe that there are two key fundamental infrastructures required to support the successful launch of the service:

- Provincial wide connectivity – To help assess if new lighting solution or sensors installed can create useful insights from leveraging large network of connected light bulbs
- Existing street light installed in city area – To help understand if Phuket has existing lighting system/ infrastructure to support the quick launch and scalability of the service in both short and long terms

From the assessment of above infrastructures, we believe that Smart Lighting can potentially be launched in major areas of Phuket as they have wide range coverage of LPWAN with large number of installed lamp posts throughout the city area. This solution can be firstly rolled out in the city to test the service feasibility and identify operational gaps prior to the service extension.

Other than infrastructure, we have also analyzed current regulations to understand whether this solution complies with current regulation or not as well as to determine the feasibility of the service. Currently, there is no regulation that will limit the launch of this service, however, the permission/ approval is still required prior to modifying or installing new light bulbs system on the existing lamp post/ infrastructure. Moreover, the light bulbs for Smart Lighting must follow specification of industrial product listed by the Thai government. Generally, the street light operators are varied across different city areas such as Department of Highway is responsible for connecting highway while municipalities are responsible within their district, etc. Therefore, the solution developer is required to strictly follow rules/ guidelines established by government at both national and micro level.

Based on current situation and geography, Phuket has full potential to turn ~1,500 of street lighting points to support Smart Lighting solution.

Key Stakeholders

Stakeholders for service set up and/ or operations – Public authorities that set up lighting infrastructure and provide Smart Lighting management and operations. Below figure shows the value chain of Smart Lighting operations and management in Phuket.

	Construction of light posts & frame	Installation of light bulbs & system	Electricity supply	Light operations & maintenance
Descriptions	> Lay out lamp post and frame construction and installed locations across the city > Develop infrastructure to support lighting system	> Procure and install light bulbs following industrial specification > Construct the operating system between light bulbs and operations center	> Supply electricity to support lighting operations across the province	> Operate day-to-day lighting schedule including deploying resources to conduct inspection and maintenance
Stakeholders	Roads within cities: Phuket City Municipality; Town municipalities; Sub-district municipalities Inter-city roads: Phuket Highway District Roads in rural areas: Phuket Rural Road District		Provincial Electricity Authority (PEA)	Roads within cities: Phuket City Municipality; Town municipalities Inter-city roads: Phuket Highway District Roads in rural areas: Phuket Rural Road District

Planned & Ongoing Initiatives

Stakeholders for service initiatives – Both public and private parties are involved in the development of Smart Lighting solution. Phuket currently has one initiative to help support local governments to enhance safety and energy usage efficiency.

	Initiative description	Coverage/ investment	Benefits	Stakeholders
Initiative 1	> Signed MOU – October 2017 > **PKCD** has signed MOU with NIDA to support the launch of Smart Lighting solution along the coastal area and city area in Phuket, Patong and Wichit Municipalities – Intelligent lighting system aims to support the automatic lighting operations and enhance coverage of bright areas	> No detailed service coverage and investment available; Only concept or vision available	> Expected to enhance safety for local and tourists in Phuket	**PKCD** – Supports on project execution, stakeholder engagement and human capital **NIDA** – Provides R&D capabilities to support product launch

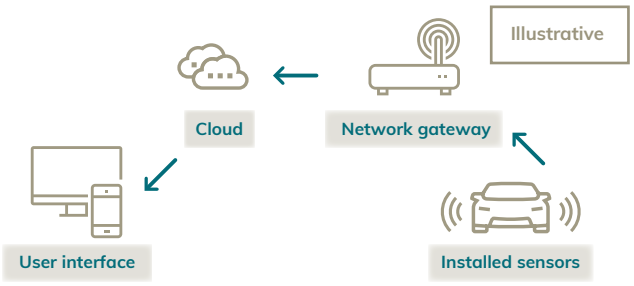
XXX = Public stakeholder

SMART PARKING

Service Overview

Function — Smart Parking involves the use of installed vehicle detection sensors, which can be in the form of in-ground, surface mount or overhead indicator sensors, to provide real time information on parking space availability. Each installed sensor emits electromagnetic (EM) wave which will be interrupted when a vehicle occupies a parking spot. The nearby network gateway will then pick up the interruption of EM wave, resulting in the detection of an occupied parking spot, before relay this information to the cloud system, or change the color of overhead LED displaying light in the case of overhead indicator sensors. The real time information stored in cloud system can either be displayed on mobile application or digital signage so that drivers are aware of the parking availability.

Smart Parking also aims to optimize parking space through the use of automation such as robots that pick up and deposit vehicles to separated parking spots where vehicles are stacked closely together without the need for walkways and turning spaces.



Benefit — The main benefit of Smart Parking is the reduced time spent by drivers idling and/ or circling within car parks. Since idle vehicles or those that move with low speed tend to produce more air pollution, additional benefit can be realized in the form of reduced environmental emissions and hence, improved air quality. Analyses of parking data can also help in understanding parking behavior and therefore, further optimize the parking system.

Global Case Studies

The following case studies show three successful examples of Smart Parking solutions on a global scale. These solutions include provision of real time parking space availability information with mobile payment system, robotic parking system and automatic number plate recognition (ANPR). However, they all have a common objective which is to optimize the parking process and maximize parking experience for drivers. The solution providers are private parties who will be involved in solution development, sensors installation, hardware integration, trial & testing, facility training and maintenance. Operations are on the other hand generally done by owners of real estates where Smart Parking solutions are installed.

Case study 1: Wellington, New Zealand

Status & scale:
- Implemented in 2016
- Over 3,800 RFIDequipped in-ground vehicle detection sensors installed citywide

Service overview
- Provide real time information on parking space availability throughout the city on mobile application, guiding drivers directly to nearby unoccupied parking spots
- Allow drivers to remotely pay parking fees on mobile application without the need to return to their vehicles

Expected/ realized benefits
- Reduced idling/ circling time to find available parking spots
- Improved parking experience for drivers
- Improved local business due to higher access to CBD

Relevant stakeholders

Smart Parking (private) - Provides end-to-end solution including detection sensors and mobile application

Wellington City council (public) - Operates solution and collects generated data for further optimization

XXX = Service operator

Case study 2: Düsseldorf, Germany

Status & scale:
- Implemented in 2014
- 3 robots and 6 transfer stations installed for room to park up to 240 vehicles

Service overview
- Provide robotic parking system that scans vehicle size and carries the vehicle directly to the assigned parking spot based on measurements taken
- Connect to airport's flight database to tailor the picking up time for drivers

Expected/ realized benefits
- **~40% additional space** as vehicles can be parked in closer proximity compared to conventional parking
- Close proximity from parking spot to destination due to separation of drop-off and parking areas
- Reduced hassle in searching for parking spot due to the drop-off at spacious transfer station

Relevant stakeholders

Serva Transport Systems (private) - Provides robotic parking system

Lumod (private) – Designs machine and measurement tools

Düsseldorf Airport (PPP) - Operates solution and provide parking space

XXX = Service operator

Case study 3: Los Angeles, USA

Status & scale:
- Implemented in 2012
- Camera-based sensors with overhead indicators installed throughout the multi-level car park (over 500 spaces)

Service overview
- Provide camera-based sensor system that can recognize and monitor license plates of each vehicle
- Integrate with parking access revenue control systems at the site to charge appropriate

Expected/ realized benefits
- Enforced multiple parking policies, e.g., different parking rates for retail customers and office tenants, different parking zone allocation, etc.
- Easier navigation back to drivers' parked vehicles
- Increased parking safety from tracking and identifying vehicles' plate numbers

Relevant stakeholders

Park Assist (private) - Provides camera-based sensor system

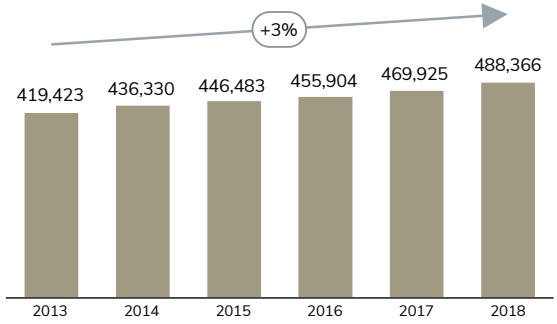
FIGat7th (private) - Operates solution and collects generated data for further optimization

XXX = Service operator

Service Relevance to Phuket

Smart Parking is relevant to city/ province which has high traffic congestion issue due to high number of vehicles on the road as it can alleviate the issue by offering more efficient parking and traffic management solutions.

Number of registered vehicles [#]

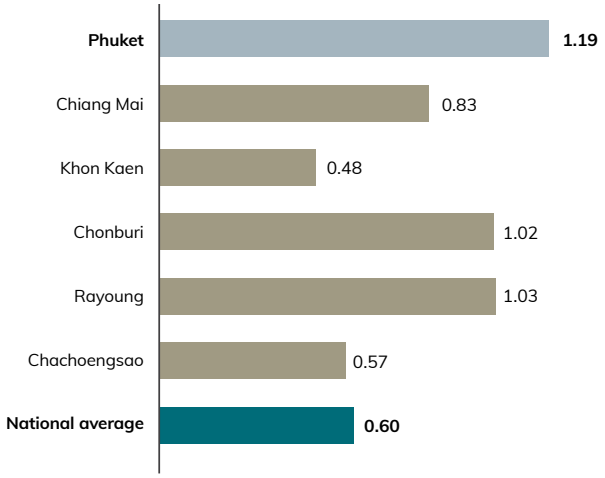


Source: Department of Land Transport

As the number of registered vehicles in Phuket has been gradually increasing at 3% CAGR and is also expected to increase steadily in the future, more number of parking spots will be needed in order to support the increasing amount of vehicles. However, given the limited amount of space for expansion and high upfront investment in building new parking facilities, there is a need for innovative solutions to tackle these issues.

The significance and necessity of innovative solutions are also emphasized by the increasing number of local complaints on heavy traffic congestion especially during rush hours and high seasons due to high influx of tourists, as well as increasing number of reports on inconvenience in finding parking spots as drivers often need to drive around multiple times to find available on-street parking spots while off-street parking is, on the other hand, often full.

Number of vehicles per capita by province, 2018 [#]



Source: Department of Land Transport, Department of Provincial Administration

The local complaints on heavy traffic congestion in Phuket is also backed by the number of vehicles per capita of 1.19 which stems from 488,366 registered vehicles for the total Phuket population of 410,211 in 2018. This figure far exceeds the national average of 0.60 and is also considered to be one of the highest in Thailand.

With all the related factors considered, we believe that Smart Parking is highly relevant for Phuket and will surely play a major role in supporting local communities by solving traffic congestion in a shorter run, as well as optimizing limited parking spaces and traffic management in a longer run. The demand for vehicle detection sensors will experience steady growth in the early years with increasing growth in the later years due to the successful pilot launch as well as increasing support from all parties as more benefits will become more evident and well-realized over the years

Service Readiness

We have assessed the required infrastructure and regulations to determine the readiness of Phuket to launch Smart Parking service.

Successful Smart Parking solution deployment will heavily rely on strong network of internet to ensure smooth connections between sensors, receptors and end-user interface so that published information could be as real time as possible. Based on the current situation on infrastructure, Smart Parking could potentially be launched as the local government has already granted a significant budget to support the installation of at least 1,000 additional Wi-Fi points throughout the city.

The key challenge will however lie in the high amount of financial support required. This is because in order to realize the full potential and benefit of Smart Parking solution, a largeenough number of vehicle detection sensors will need to be installed and operate collectively together.

On the other hand, we have also studied regulations required to operate such solution which will be heavily relied on the use of mobile application. Currently, there is no regulation that will limit the launch as the operator does not need to obtain any licenses to operate mobile application platform. However, solution provider will need to obtain permissions from building owners and municipality to install vehicle detection sensors in off-street and on-street parking space respectively.

488,366 registered vehicles for the total Phuket population of 410,211 in 2018.

Key Stakeholders

Stakeholders for service set up and/ or operations – Public and private parties that will be involved in the setting up and deployment of Smart Parking solution in Phuket.

	Sensors installation	System integration	Testing & training	Operations	Maintenance
Descriptions	> Install vehicle detection sensors at each parking spot	> Connect both required software and hardware together to ensure that the system is wellfunctioned	> Perform system testing > Provide required training to operators	> Run the service on a day-to-day basis > Ensure smooth operations	> Perform regular check ups > Repair and/ or replace any necessary devices
Stakeholders	Solution provider			On-street parking: Phuket City Municipality; Town municipalities; Sub-district municipalities Off-street parking: Building owners	Solution provider

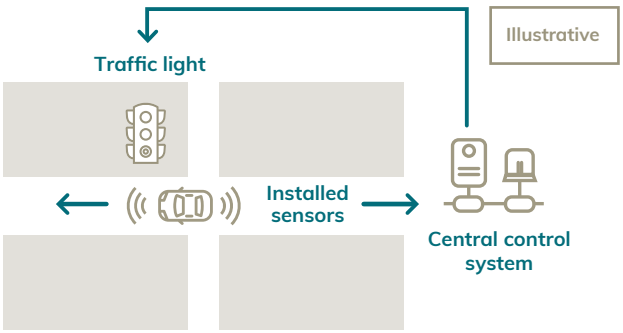
Planned & Ongoing Initiatives

There are no planned & ongoing initiatives on Smart Parking in Phuket

SMART TRAFFIC LIGHT

Service Overview

Function – Smart Traffic Light involves the use of arrays of sensors, computerized algorithms and/ or artificial intelligence (AI) on top of the traditional traffic signal system to optimize the traffic signal timing by monitoring traffic conditions so that the timing of red and green lights could be automatically adjusted accordingly. This would result in a more efficient flow of vehicles at intersections as more vehicles could be sped through intersections and thus reducing the amount of traffic congestion.



As vehicles approach traffic lights at intersections, either inground vehicle detection sensors or attached sensors on the AIbased camera will detect and identify amount of approaching vehicles as well as their speed and direction of travel. These information will then be processed by the central control system which will in turn adjust and control the length and frequency of both red and green lights in order to maintain a free flow of traffic at intersections.

Benefit – The main benefit of Smart Traffic Light system is the reduction in average traveling time and the resulting reduction of traffic congestion hours. Smart Traffic Light could also bring benefits which are well beyond the improvement of driving experience and convenience for drivers. By reducing the amount of traffic congestion, urban air quality could also be improved as well. This is because idling cars or those that move at low speed tend to act as one of the major sources of the greenhouse gas emissions, generating an estimated of 30 million tons of carbon dioxide annually according to the United States Department of Energy.

Global Case Studies

The below case studies show three examples of where Smart Traffic Light have been successfully implemented and deployed on a global scale. All of these case studies have exhibited realized benefits which have clearly improved traffic conditions in different cities around the world.

The deployment of Smart Traffic Light is generally done on a citywide scale so that full benefits could be realized. Based on these case studies, the implementation usually begins at some of the busiest road within the city. The upgrade of the traffic light system at these locations will act as a pilot project before the upgrade could be applied on a citywide scale.

With these case studies as benchmarks, it can be seen that typical Smart Traffic Light service is usually implemented by private companies who have designed and developed the end-to-end solutions. While the operational front of the service is normally run by the city's council who normally overlooks the road traffic condition, with the help of respective transport department who is responsible for the formulation of traffic policies.

Case study 1: Miami-Dade, USA

Status & scale:
- Implemented in 2016
- Traffic signals at 300 intersections upgraded with new traffic controllers and detection sensors

Service overview
- Optimize traffic lights at intersections through the installation of adaptive traffic signal control system which automatically optimize the timing of traffic lights based on detected information on traffic conditions
- Shift the decision-making responsibility for traffic light controlling to computer system for more efficient traffic

Expected/ realized benefits
- **Reduction** in average travelling time by about **10 minutes**
- **Increased** traffic speed for drivers by about **49 seconds**
- Approximately **additional 10 vehicles** through intersection for every green light period

Relevant stakeholders

Econolite Control Products (private) - Provides Smart Traffic Light system and related software

Department of Transportation and Public Works (DTPW), Miami-Dade County (public) - Manages traffic flow, operates traffic light and collects generated data forfurther optimization

XXX = Service operator

Case study 2: Copenhagen, Denmark

Status & scale:
- Implemented in 2016
- Intelligent traffic signals that prioritize buses and bikes installed at city's 380 intersections

Service overview
- Operate with adaptive signal control system which leverages the use of enhanced vehicle detection sensors to monitor traffic conditions and adjust the timing of traffic signals
- Allow buses to communicate their exact locations as well as any delays

Expected/ realized benefits
- **Reduction** of cyclists' travel time by **10%** and buses' by **up to 20%**
- **Reduction** in the energy usage of traffic signals **by 1/3**
- Expected increase in number of people partaking in cycling – Already accounts for 45% of total commuters

Relevant stakeholders

Consortium of Citelum, Technical University of Denmark and Leapcraft (private) - Develops and provides Copenhagen Intelligent Traffic Solutions (CITS) platform

The City of Copenhagen (public) - Manages traffic flow, operates traffic light and collects generated data for further optimization

XXX = Service operator

Case study 3: Milton Keynes, UK

Status & scale:
- Implemented in 2018
- 411 of smart traffic cameras installed at strategic locations citywide, totalling 104 junctions and 812 carriageways

Service overview
- Provide AI-powered cameras that monitor the traffic conditions by scanning traffic and recognize different vehicle types
- Allow longer green light period than usual when detecting queuing traffic containing large number of buses

Expected/ realized benefits
- Ability to predict traffic conditions **15 minutes in advance** with **~89% accuracy**
- Deep insights on traffic conditions and route popularity based on localized data obtained from different locations at different times during the day

Relevant stakeholders

Vivacity Labs (private) - Develops and provides Smart Traffic Light system

Milton Keynes Council (public) - Manages traffic flow, operates traffic light and collects generated data for further optimization

Innovate UK (public) – Provides funding

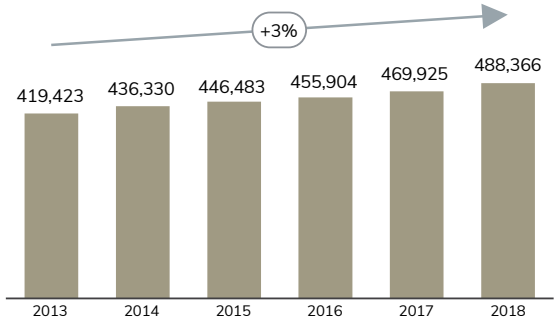
Tracsis Group (private) – Provides funding

XXX = Service operator

Service Relevance to Phuket

Smart Traffic Light is relevant to city/ province with high traffic congestion issue as a result of high number of vehicles on the road. It can facilitate the traffic flow by monitoring real time traffic conditions and leverage these information to achieve a more efficient urban traffic. Smart Traffic Light will also be relevant to city/ province with high number of road accidents as well as traffic law violations, since equipped cameras could also monitor speeding and quickly identify any violations and accidents.

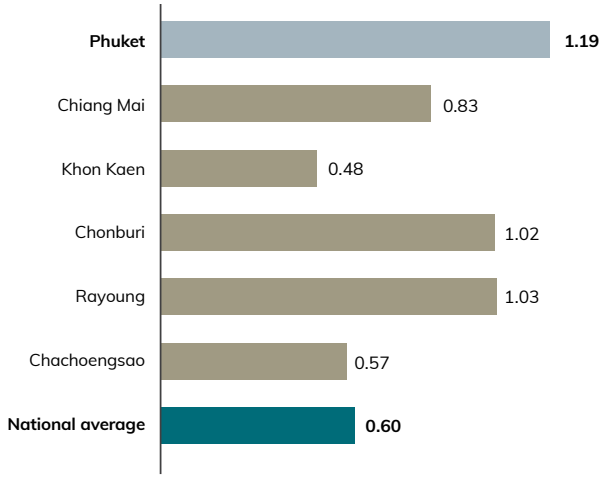
Number of registered vehicles [#]



Source: Department of Land Transport

As the number of registered vehicles in Phuket has been gradually increasing by about 3% CAGR within the past six years and is also expected to increase in the future, heavy traffic congestion issue will still remain as a major problem for drivers. Hence, there is a need for solutions that can solve this issues in a long run. The significance and necessity of innovative solutions are also emphasized by the increasing number of local complaints on heavy traffic congestion especially during rush hours and high seasons due to high influx of tourists.

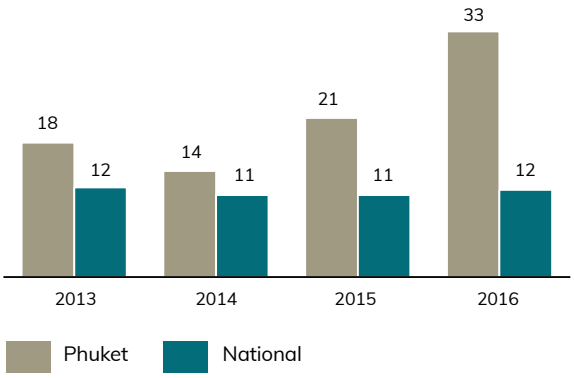
Number of vehicles per capita by province, 2018 [#]



Source: Department of Land Transport, Department of Provincial Administration

The heavy traffic congestion issue in Phuket is also supported by the number of vehicles per capita of 1.19 which comes from 488,366 registered vehicles for the total Phuket population of 410,211 in 2018. This figure is approximately twice the figure of Thailand's average of 0.60 and is also considered to be one of the highest in Thailand.

Percentage of road accidents caused by speeding violation [%]



Source: Royal Thai Police

Additionally, the proportion of road accidents caused by violating the speed limit has also been increasing in Phuket, leading up to 33% of total road accidents in 2016. Phuket's figures have been higher than figures for national average and are expected to follow the same trend. Therefore, it is clear that speeding is one of the main causes of road accidents within Phuket and should be closely monitored to reduce the number of accidents in the future.

With all the statistical evidences considered, we believe that Smart Traffic Light is very relevant for Phuket and will play an important role in solving traffic congestion issue, optimizing local traffic management and reducing the number of road accidents.

As benefits of Smart Traffic Light solution on improving traffic conditions within Phuket become more evident over the years, we believe that there will be growth in demand as well as increase in support from both public and private parties, which will result in both smoother implementation and operational processes.

violating the speed limit has also been increasing in Phuket, leading up to

33%

of total road accidents in 2016.

Service Readiness

We have assessed the required infrastructure and regulations to determine the readiness of Phuket to launch Smart Traffic Light service.

Successful Smart Traffic Light solution deployment will heavily rely on strong network of internet to ensure smooth connections between sensors, receptors and end-user interface so that published information could be as real time as possible.

Based on the current situation on infrastructure, Smart Traffic Light could potentially be launched as upgrades on top of traditional traffic light system which is already installed at majority of crossings in urban areas. Wi-Fi points are also currently available in some of the strategically important areas within the city, with the local government also granting a significant amount of budget to support the installation of at least 1,000 additional Wi-Fi points throughout the city.

The key challenge will however lie in the high amount of financial support required. This is because in order to realize the full potential and benefit of Smart Traffic Light solution, a large enough number of vehicle detection sensors will need to be installed and operate collectively together.

> *"With the help of Smart Traffic Light that can optimize traffic signals based on real time traffic flow, Phuket will easily be able to solve its traffic congestion problem"*
>
> - Chief -
> Phuket Highway District

On the other hand, we have also studied regulations required to operate such solution, and currently there is no regulation that will limit the launch of such service.

Key Stakeholders

Stakeholders for service set up and/ or operations – Public and private parties that will be involved in the setting up and deployment of Smart Traffic Light solution

	Traffic policies setup	Traffic lights installation	Smart Traffic Light installation	Operations	Maintenance
Descriptions	> Develop and systemize traffic policies > Submit policies, formulate traffic plans and establish traffic safety measures	> Install traffic light signals at each intersection	> Upgrade traditional traffic lights with adaptive control system > Perform system testing > Provide required training to operators	> Run the service on a day-to-day basis > Ensure smooth operations	> Perform regular check ups > Repair and/ or replace any necessary devices
Stakeholders	Phuket Land Transport Office Office of Transport and Traffic Policy and Planning	Roads within cities: Phuket City Municipality; Town municipalities; Sub-district municipalities Inter-city roads: Phuket Highway District Roads in rural areas: Phuket Rural Road District Solution provider	Solution provider	Phuket Provincial Police	Roads within cities: Phuket City Municipality; Town municipalities; Sub-district municipalities Inter-city roads: Phuket Highway District Roads in rural areas: Phuket Rural Road District Solution provider

Planned & Ongoing Initiatives

Stakeholders for service initiatives — Public and private parties involved in development of Smart Traffic Light solution. Phuket currently has only one ongoing Smart Traffic Light initiative to help support local government in traffic related issues.

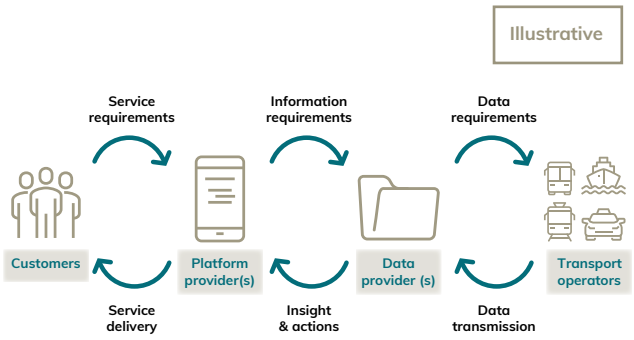
	Initiative description	Coverage/ investment	Benefits	Stakeholders
Initiative 1	> Ongoing – Started in 2017 > Cameras with ability to identify license plates and automatically trigger fines to motorcyclists not wearing helmets and vehicle owners caught running red lights and speeding	> Installation of 3 red light traffic cameras at each of the 5 key intersections	> **45,000-60,000 instances** of motorcyclists not wearing helmets captured monthly > **Over 5,000 instances** of running red light captured monthly > **Over 150 instances** of speeding captured monthly	**Safer Roads Foundation** – Provides traffic cameras and related software **Phuket Provincial Police** - Manages traffic flow and operates cameras

XXX = Public stakeholder

SMART PUBLIC TRANSPORT

Service Overview

Function – Smart Public Transport aims to improve convenience for commuters as well as increase urban accessibility, through the encouragement of public transport usage. It is a range of multi- modal and demand responsive mobility solutions that satisfy commuters' diverse public transportation requirements through a single and collective digital platform, often mobile application. Smart Public Transport service offers customized travel options by providing real time information on all publicly available mobility services within the city such as city buses and trains, through the help of tracking system. The service also includes both booking and payment/transaction system so that commuters can plan their journey well in advance, book the right tickets and immediately pay for their trips within a single platform. Smart Public Transport ecosystem often depends on a network of interconnected parties which include commuters/ customers, platform provider(s), data provider(s) and transport operators.



Benefit – Benefits for Smart Public Transport will be fully realized if the platform could incentivize people to depend less on their private vehicles in favor of public transportation modes. Some of the clear benefits for Smart Public Transport service are reduction in traffic congestion, improved air quality due to lower environmental emissions from lower number of vehicles on the road, improved commuters' travel experience through the use of all-in-one platform and more optimized management of existing transport networks and infrastructure according to actual travel demand.

Global Case Studies

Three case studies below exhibit successful examples of Smart Public Transport that have been in operation around the world. As their realized benefits have successfully encouraged commuters to use more public transport and rely less on their private vehicles, these examples can be used as benchmarks for further studies so that successful service could be launched by providers in the future.

Generally, the deployment of Smart Public Transport service is conducted on a citywide scale in order for benefits to be fully realized. Based on the following examples, digital platform development is usually done and is responsible by a single provider who connects customers to public transport services by providing data retrieved from various transport operators within the city via their designed digital platform.

Case Study 1 : Vienna, Austria

Status & scale:
- Implemented in 2017
- "WienMobil" mobile application with access to bus, tram, metro, taxi, bike/ car sharing and car rental services

Service overview
- Provide end-to-end platform that allows commuters to completely plan, book and pay for their journeys
- Allow commuters to choose travel options based on their personal preferences, with option to see how much energy and money savings could be achieved by choosing transport mode of choice

Expected/ realized benefits
- **20% increase** in urban public transport usage
- Reduction in usage of private vehicles by approximately 20%
- Transparent and easily-accessible real time information of all publicly available modes of transport in Vienna

Relevant stakeholders

Wiener Linien (private)
- Provides mobile application platform and real time public transport data (but, tram, metro)

Related public transport operators (public and private)
- Provide real time public transport data (taxi, bike/ car sharing, car rental)

XXX = Service operator

Case study 2: Helsinki, Finland

Status & scale:
- Implemented in 2016
- "Whim" mobile application with access to bus, tram, metro, train, ferry, taxi, bike/ car sharing, car rental services

Service overview
- Provide end-to-end platform that allows commuters to completely plan, book and pay for their journeys
- Offer route optimization supporting journey planning
- Provide both monthly subscription and pay as you go plans

Expected/ realized benefits
- **Expected 26%** increase in modal share of public transport
- **Decrease** in private vehicles usage by **20%**

Relevant stakeholders

MaaS Global (private)
- Provides mobile application platform

Related public transport operators (public and private)
- Provide real time public transport data (bus, tram, metro, train, ferry, taxi, bike/ car sharing, car rental)

XXX = Service operator

Case study 3: Dubai, UAE

Status & scale:
- Implemented in 2013
- "Wojhati" mobile application with access to bus, tram, metro and waterbus services

Service overview
- Provide end-to-end platform that allows commuters to completely plan, book and pay for their journeys
- Offer Virtual Reality (VR) feature based on integrated Augmented Reality (AR) technology with which users can identify stops/ stations in real time environment

Expected/ realized benefits
- **6% increase** in percentage of citizens using public transportation
- **60% increase** in on-time performance management
- **Reduction** in complaints on late arrival of vehicles from **500 to 15 per day**

Relevant stakeholders

Roads & Transport Authority (public)
- Provides mobile application platform

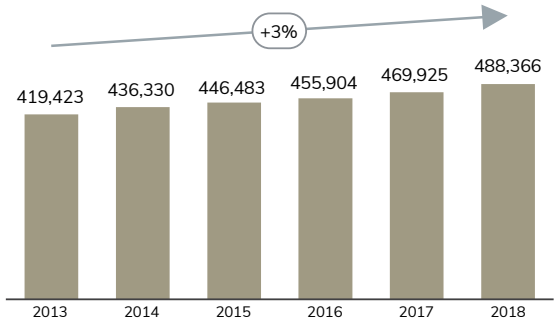
Related public transport operators (public and private)
- Provide real time public transport data (bus, tram, metro and waterbus)

XXX = Service operator

Service Relevance to Phuket

Smart Public Transport is relevant to city/ province that has heavy traffic congestion issue mostly due to the high number of vehicles

Number of registered vehicles [#]

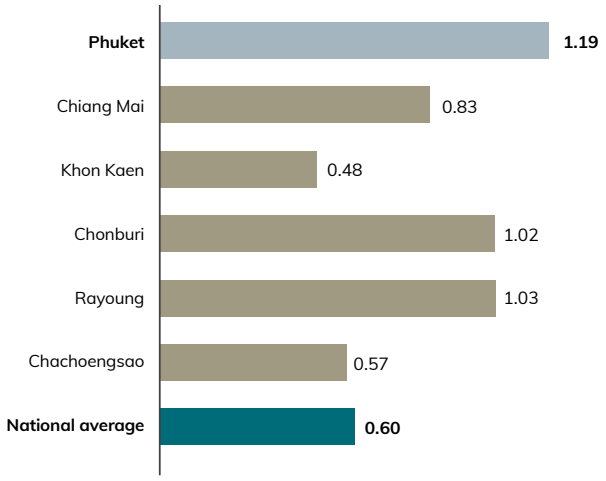


Source: Department of Land Transport

ownership. Since Smart Public Transport service will play a major role in facilitating commuters around the city with seamless travel experience by providing a platform that assists commuters in planning, booking and paying for their trips using public transport services, extensive network of public transport will therefore be one of the key drivers of service demand. This is because the more widespread the network and the wider the range of publicly available public transport modes, the more benefits the city/ province can realize from the launch of the citywide service. The service will also be relevant to city/ province that currently has limited real time information on public transport available.

The number of registered vehicles in Phuket has been gradually increasing by about 3% CAGR in the past six years and is also expected to increase in the near future. This indicates that traffic congestion will still remain as one of the urban problems. The issue is also emphasized by the increasing amount of complaints on heavy traffic congestion from locals, especially during rush hours and high seasons.

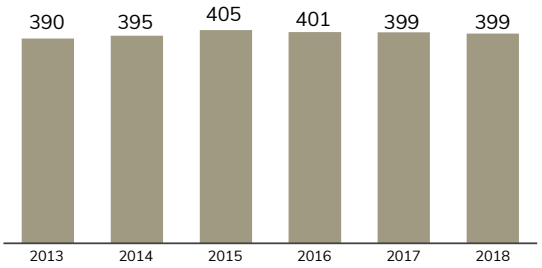
Number of vehicles per capita by province, 2018 [#]



Source: Department of Land Transport, Department of Provincial Administration

Heavy traffic congestion issue in Phuket is also backed by the fact that Phuket has about twice as high the number of vehicles per capita when compared to the national average. In 2018, the figure for Phuket was 1.19, coming from 488,366 registered vehicles for the total Phuket population of 410,211, while the national average figure was 0.60.

Number of fixed route public bus [#]



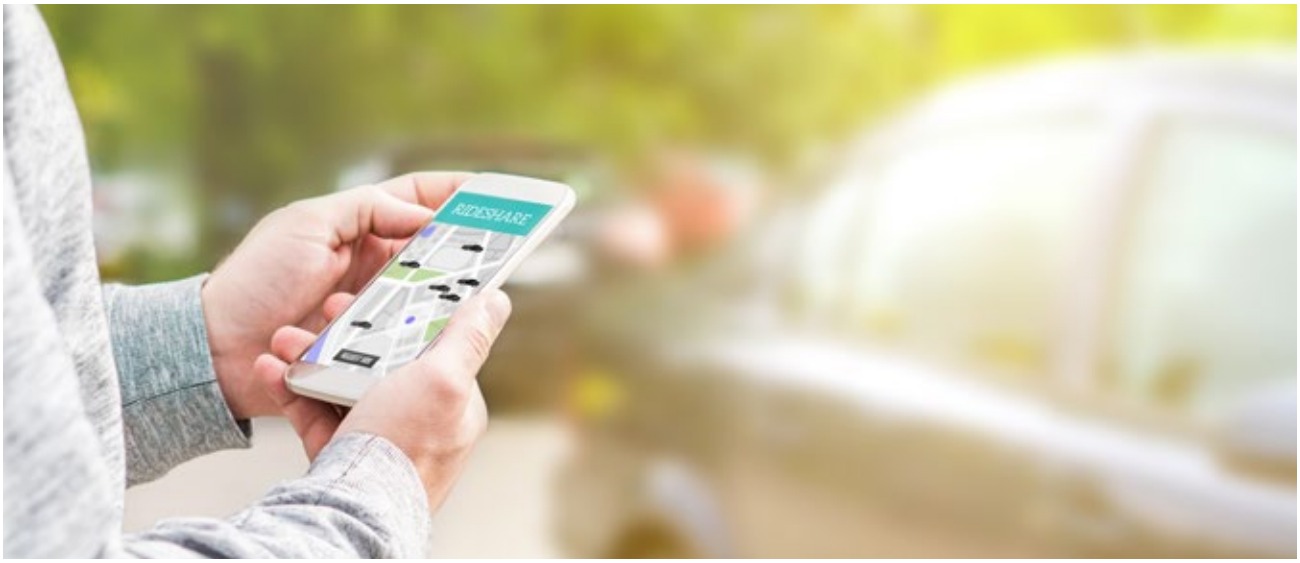
Source: Department of Land Transport

In terms of public transport network, Phuket has a reasonable coverage with three main types of public transport being bus, Songthaew and motorbike taxi. Out of these three modes, Smart Public Transport service will likely be relevant to bus due to its fixed route nature which allows for the provision of real time information on schedule and vehicle locations, as it would be difficult to monitor public transport modes with non-fixed route on the other hand. The fact that the number of fixed route buses in Phuket has remained fairly constant within the past six years illustrates that there has not been a major attempt at expanding the operation scale. This is possibly because getting around the city on Songthaew and motorbike taxi is more convenient due to the higher availability of vehicles and the non-fixed route nature which allows for flexibility in travel route.

Additionally, there is also very limited amount of real time information regarding public transport services in Phuket. Currently, there is one mobile application which provides real time information of bus routes and schedules. However, this is only covers two routes inside Phuket. Information on routes and schedules for bus and Songthaew are generally only available at stops with limited amount available online. This often proves to be very difficult for tourists/ visitors as they need to rely on asking locals for accurate information, and hence prevents many from planning their journey well in advance.

Having considered the aforementioned factors, we believe that there is a room to deploy Smart Public Transport service in Phuket. The service will surely play a major role in improving experience for commuters when traveling around Phuket and, as a result, will be able to reduce the usage of private vehicles in the long run. This is mainly due to the reasonably high number of fixed route bus per capita (Phuket's figure is in line with national average) as well as the lack of real time information on public transport.

As benefits of Smart Public Transport solution become more evident over the years, we believe that there will be growth in demand as well as increase in support from both public and private parties, which will result in both smoother implementation and operational processes.



Service Readiness

We have assessed the required infrastructure and regulations to determine the readiness of Phuket to launch Smart Public Transport service.

Successful Smart Public Transport solution deployment will heavily rely on strong network of internet to ensure stable connections and smooth operations between data provider(s), platform provider(s) and end-user interface so that published information could be as up-to-date and as accurate as possible.

Based on the current situation on infrastructure, Smart Public Transport could be easily deployed as Wi-Fi points are currently available in strategically important areas within the city, with the local government also granting a significant amount of budget to support the installation of at least 1,000 additional Wi-Fi points throughout the city.

Data management is also a key factor for successful deployment. In order to achieve effective operation, it is necessary for transport operators to be very transparent when it comes to sharing their operational data. This means that obtaining full alignment and cooperation from transport operators will be necessary as well.

On the other hand, there will be some regulatory barriers such as data privacy when considering launching Smart Public Transport service as personal information of commuters inputted on mobile application platform must also be protected. However, these barriers are not significant enough to adversely affect the successful implementation of the service in the long run.

Phuket has about twice as high the number of vehicles per capita when compared to the national average.

> *"Free public Wi-Fi throughout the island is a must. We will heavily rely on this strong network connection to make Phuket a safer, cleaner and more destination for tourists"*
>
> - President -
> Patong Development Foundation

> *"Traffic congestion is very common in Phuket as number of registered cars have been increasing. Moreover, local people prefer to use their own private vehicles over the public transport as they are not fully developed in some areas"*
>
> - Mayor -
> Sri Sunthon Sub-district Municipality

Key Stakeholders

Stakeholders for service set up and/ or operations – Public and private parties that will be involved in the setting up and deployment of Smart Public Transport solution

	Public transport policies setup	Public transport data provision	Public transport O&M	Digital platform O&M
Descriptions	> Develop and systemize policies on public transport > Submit policies and formulate safety measures	> Provide real time data on schedule, vehicle location, pricing, booking availability, etc.	> Run the public transport service on a day-to-day basis > Ensure smooth operations > Perform regular check ups and repair when necessary	> Ensure smooth operations on the platform > Perform regular check ups and constantly update platform
Stakeholders	Phuket Land Transport Office Office of Transport and Traffic Policy and Planning	Bus: Phuket Smart Bus, Various local bus operators Songthaew: Phuket Songthaew Co-operative	Solution provider	

Planned & Ongoing Initiatives

Stakeholders for service initiatives – Public and private parties that will be involved in the development and deployment of currently available Smart Public Transport solution in Phuket. Phuket currently has only one ongoing Smart Public Transport initiative to help support the local government in commuting experience enhancement and public transport usage encouragement

	Initiative description	Coverage/ investment	Benefits	Stakeholders
Initiative 1	> Ongoing – Started in 2017 > Bus Beam mobile application created under the "Smart Bus, Smart Passengers" project > Platform with ability to – Track buses' real time location and schedule – Make personalized journey planning in advance	> Service currently covers 2 local buses routes inside Phuket, as well as 5 inter-provincial routes running to 3 nearby provinces	> Improved commuting experiences on public transport vehicles > Expected increase in number of passengers	**Phuket Provincial Land Transport Office** - Provides mobile application platform **Taxi-Beam** – Develops mobile application platform **Andaman Tracking** – Provides and installs GPS on local buses **Patong Development Foundation** – Provides funding

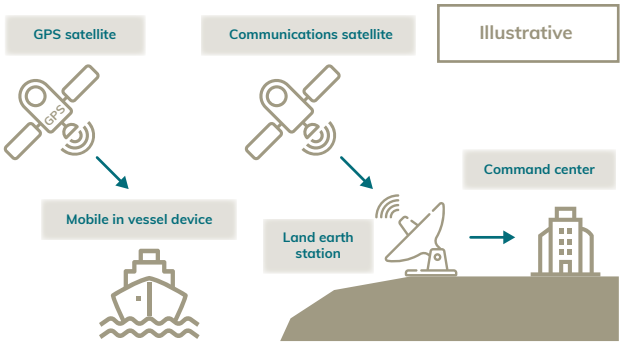
XXX = Public stakeholder

VESSEL TRACKING & MONITORING SYSTEM

Service Overview

Function – Vessel Tracking & Monitoring System is the system that is able to provide real time information of vessels through the use of tracking systems that leverage GPS technology. The system is designed to provide up-to-date information on exact vessel location, schedule and navigational status, which will be very useful for in advance ferry journey planning by tourists, fleet schedule management optimization as well as location tracking of vessels for safety purpose by vessel operators.

Vessel Tracking & monitoring System works through the wireless communication, often through the use of communications satellite, between onshore and offshore units.



Principal components include the following:

- GPS satellite – Connect with vessel and identify its location and navigational status
- Mobile in-vessel device – Transmit signal with data received from GPS satellite to communications satellite
- Communications satellite – Transmit received signal to onshore land earth station
- Land earth station – Process and analyze data before transferring to command center via connected cloud system
- Command center – Monitor vessels from onshore and issue necessary measures in case of emergencies

Benefit – There are many benefits that can be realized from the implementation of Vessel Tracking & Monitoring System both by general public and vessel operators. Firstly, tourists and/ or citizens will be able to plan their marine travel routes in advance due to the availability of the real time schedule. Secondly, vessel operators will be able to efficiently manage vessel traffic and schedule. Lastly, vessel safety will also be enhanced as vessel's precise location are always closely monitored.

Global Case Studies

Below are three case studies of Vessel Tracking & Monitoring System that have been successfully launched around the world. They have exhibited aforementioned benefits and thus can be used as benchmarks for further studies so that successful launch of new initiatives as well as optimization of existing initiatives could be achieved in the future.

These examples also illustrate that successful launch depends on strong collaboration between both public and private parties Onshore unit is often operated by public stakeholders while private stakeholders often provide the technological expertise and infrastructure needed to monitor vessels offshore

Case Study 1: Jacksonville, USA

Status & scale:

- Implemented in2013
- Real time information available for ferries traveling across St.Johns River (between Mayport Village and Fort George Island)

Service overview

- Provide up-to-the-minute real time information on ferry's precise arrival and departure times, precise current location and navigational status
- Provide other general information such as schedule, fares and special announcement about service interruptions and delays

Expected/ realized benefits

- Efficient route planning for ferry commuters
- Expected decrease in over ground transport which in turn reduce environmental emissions

Relevant stakeholders

City of Jacksonville (public) – Develops and provides mobile application platform

St. Johns River Ferry Commission (public) – Develops and provides mobile application platform as well as provide general information on ferry service

XXX = Service operator

Case study 2: Pittsburgh, USA

Status & scale:

- Implemented in 2013
- Wireless-Hybrid Broadband Systems covering 120 miles of Pittsburgh's 3 river areas, with additional coverage on 4 nearby locks and dams

Service overview

- Provide precise tracking system that update vessel locations every 30 seconds for both commercial and recreational vessel operators
- Provide platform with Google Earth overlays where users can toggle layers such as weather, water depth, water quality and obstacle locations

Expected/ realized benefits

- Improved navigation safety due to improved visibility for vessel tracking
- High-speed two-way communication among vessels, as well as between vessels and onshore operational units

Relevant stakeholders

Port of Pittsburgh Commission (public) – Provides funding, develops and launches platform

Carnegie Mellon University (private) – Develops platform

National Oceanic and Atmospheric Administration (public) – Provides integrated data

United States Army Corps of Engineers (public) – Provides integrated data

United States Coast Guard (public) – Provides integrated data

United States Department of Homeland Security (public) – Provides funding

XXX = Service operator

Case Study 3: Mexico (various gulf areas)

Status & scale:
- Implemented in 2015
- System installed on 950 boats that fish in the Gulf of Mexico, Gulf of California and Caribbean Sea

Service overview
- Provide system that tracks exact location of vessels and sends out reports to control center every hour with information on position, date, time, speed and direction of travel
- Provide panel with panic button that induces visual and audible alarms in case of emergency
- Define geofences with rules of operation for both national and international maritime waters

Expected/ realized benefits
- Substantial savings achieved through smarter operations
- Elimination of work redundancy due to more organized data
- Ability to immediately detect irregular situations by regulators

Relevant stakeholders

National Commission on Aquaculture and Fisheries (public) – Manages and monitors operations of all vessels

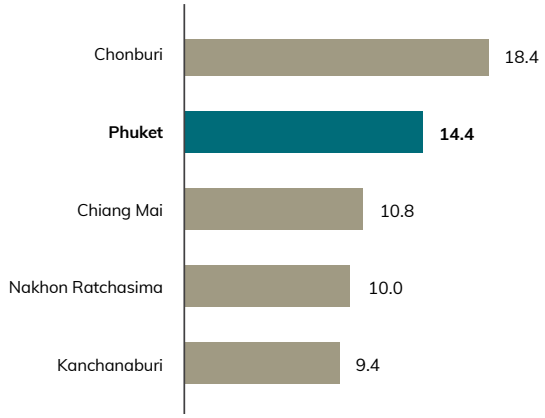
Astrum Satelital (private) – Develops and integrates end-to-end vessel monitoring system

XXX = Service operator

Service Relevance to Phuket

Vessel Tracking & Monitoring System is mostly relevant to city/ province that is connected to the sea. Since the service is applicable to commercial/ recreational ferries for visitors as well as fishing vessels, the service demand is therefore driven by the number of tourists and the number of commercial fishing vessels respectively.

Number of visitors in Top 5 provinces (excluding Bangkok), 2018 [# m]

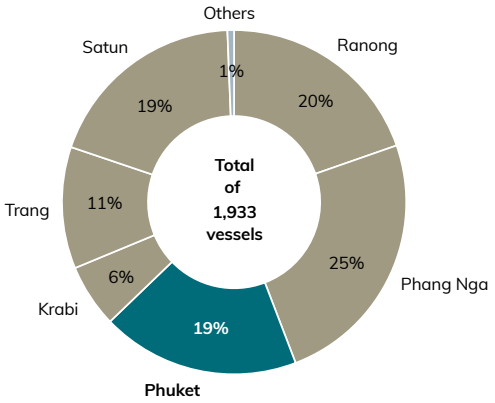


Source: Ministry of Tourism and Sports

As Phuket is considered as one of the top global destinations in the world, it generally attracts a vast amount of visitors every year. In 2018, Phuket has attracted approximately 14 million visitors in total. This is considered the second highest out of all provinces (excluding Bangkok) and also accounts for about 5% of total visitors in Thailand that year

the number of registered commercial fishing vessels along the Andaman coast in Phuket sums up to **360 vessels.**

Percentage of registered commercial fishing vessels in the Andaman, 2018 [#]



Source: Department of Fisheries

Fishery and aquaculture are also very popular and active in Phuket which is also the case for all other provinces that are situated along the Andaman coast. In 2018, the number of registered commercial fishing vessels along the Andaman coast in Phuket sums up to 360 vessels. The province has one of the highest number as it accounts to about 19% of total registered commercial fishing vessels in the Andaman.

Having assessed the aforementioned driving factors, we believe that there is a room for Vessel Tracking & Monitoring System to be implemented in Phuket since there are high number of visitors as well as high number of commercial fishing vessels, indicating high service demand. The service will surely play a major role in optimizing fleet operations and improving safety as a whole due to the implementation of real time tracking system.

As benefits of Vessel Tracking & Monitoring System become more evident over time, we believe that there will be growth in demand as well as increase in support from both public and private parties, which will result in both smoother implementation and operational processes.

Service Readiness

We have assessed the required infrastructure and regulations to determine the readiness of Phuket to launch Vessel Tracking & Monitoring System service.

Successful Vessel Tracking & Monitoring System deployment will mostly depend on strong network of internet to ensure stable connections and smooth operations between land earth station and command center. This means that focus areas should not cover only the urban area but also coastal areas due to the fact that command centers are likely to be situated near the coast. This is to ensure that the information on exact location, schedule and navigational status of vessels would be as real time and as up-to-date as possible.

Based on the current situation on infrastructure, Vessel Tracking & Monitoring System could be easily deployed as Wi-Fi points are currently available in strategically important areas throughout the city, with the local government also granting a significant amount of budget to support the installation of at least 1,000 additional Wi-Fi points which would cover all the major areas within the province.

Furthermore, the quality of supporting infrastructure for location tracking should also be of as high quality as possible in order to achieve high accuracy. Hence, large amount of funding would also be required to invest in appropriate models of mobile in-vessel devices and antenna at land earth stations.

In terms of regulations, there is currently no significant barriers that would adversely affect the successful deployment of the service in both short and long terms.

Key Stakeholders

Stakeholders for service set up and/ or operations – Public and private parties that will be involved in the setting up and deployment of Vessel Tracking & Monitoring System solution

	Marine traffic policies setup	Mobile in-vessel device installation	Monitoring
Descriptions	> Develop and systemize policies on marine transport > Enforce regulations to organize vessels traffic	> Install mobile in-vessel device on each of the vessel for location tracking purpose	> Monitor vessels on a day-to-day basis > Ensure smooth marine traffic along the coast and around the island > Coordinate and execute countermeasures in case of emergency
Stakeholders	Marine Office 5, Phuket	Various vessel owners	Vessel Traffic Management Center

Planned & Ongoing Initiatives

Stakeholders for service initiatives – Public and private parties that will be involved in the development and deployment of currently available Vessel Tracking & Monitoring System solution in Phuket. Phuket currently has only one ongoing Vessel Tracking & Monitoring System initiative to help support the local government in vessel traffic management

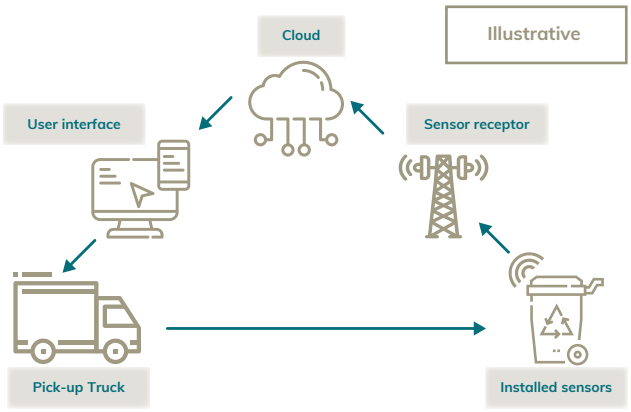
	Initiative description	Coverage/ investment	Benefits	Stakeholders
Initiative 1	> Ongoing – Started in 2014 > Vessel Tracking Management System (VTMS) allowing officials to track vessels and ensure safety of passengers	> All foreign-registered vessels coming into Thai waters are required to have an Automatic Identification System (AIS) equipment installed – AIS Class B system or higher is required – System must be turned on at all times – Cost of an AIS of THB 20,000-30,000	> Improved water transportation security, preventing maritime accidents as well as facilitating search and rescue	**Marine Office 5** – Collaborates with maritime security to implement technology **Digital Economy Promotion Agency (depa)** – Promotes initiative **Vessel Traffic Management Center at Chalong Pier** – Monitor vessels

XXX = Public stakeholder

SMART WASTE MANAGEMENT

Service Overview

Function – Smart Waste Management involves the use of installed sensors which can measure the waste level in the trash bin and send real time data to rubbish collectors. When the trash bin is nearly full, the sensor will send alerts to the rubbish collector. Along with real time information, the solution will provide optimal route planning to increase efficiency and reduce operation costs for the rubbish collectors/ operators.



In addition to the pick-up truck and trash bin, there are four other required components for Smart Waste Management solution:

- Sensor – Collects real time data of the waste level to provide optimal pick up time to the service operator
- Sensor receptor/ network gateway – Receives alerts from installed sensors
- Cloud computing – Stores data sent by installed sensors and supports data analytics
- User interface – Formulates results/ insights from data analytics

Benefit – Smart Waste Management will provide benefits to the rubbish collectors from operational costs reduction and increased waste pick up efficiency. Moreover, this solution will benefit citizens by addressing existing issues related to overfilling bins which can cause waste pollution. The solution has successfully been implemented globally. Below are three global case studies which demonstrate solution overview and realized/ expected benefits from this solution.

Global Case Studies

Below are three case studies which have shown the successful launch of Smart Waste Management at the global level. Throughout the case studies below, Smart Waste Management solution is typically paid and operated by a public party to enhance the existing collection efficiency, reduce operational costs from better route planning and minimize potential waste pollution issues caused by overfilling bins. Solution developers are generally private parties, and are usually involved at the beginning of the solution development, from network setup and integration, sensors installation, infrastructure development and trial run training.

All of the solution developers are not involved with day-to-day waste collection and operations.

Common benefits that these three case studies have realized are immediate and ongoing operational costs saving, higher waste collection efficiency and reduction of waste pollution. Common features that have been implemented across three case studies are route planning and optimization, waste level tracking and measure, automatic waste level alerts and employing cellular network. The three cases below have been selected as they are still active with some expansion plans in pipelines. They have provided proven/ tangible benefits in both short and long terms upon implementation.

Case Study 1: Cascais, Portugal

Status & scale:
- Implemented in 2018
- Sensors installed across 400 waste collection points throughout the city

Service overview
- Provide fleet management solution along with intelligent monitoring solution from the operations center
- Send real time alerts from Smart Bin to the operations center via cellular network

Expected/ realized benefits
- Realized **saving of EUR 900,000** on operational cost after 1 year of the service implementation
- **6 month payback period** achieved
- **50% reduction** in waste collection time
- Overfilling bin issues eliminated

Relevant stakeholders
Smart Bin (private) – Provides sensors and solutions interface for the operator

Cascais Ambient (public) – Operates solution and waste collection and treatment

Sotkon (private) – Collaborates with Smart Bin to enhance operating system of the solution

XXX = Service operator

Case Study 2: Philadelphia, USA

Status & scale:
- Implemented in 2010
- Over 1,500 smart bins installed across the city with ongoing solution upgrades

Service overview
- Operate sensors by using solar power compacting system
- Send alerts via cellular network to the operations center to provide route optimization and pick up schedule projection

Expected/ realized benefits
- Realized annual operational **savings of USD 650,000**
- Reported **savings of 30,500 gallons** of fuel and **335 tons of carbon dioxide emission reduction** in the first year
- **Reduced** weekly waste collection frequency by **~80%**

Relevant stakeholders
Big Belly (private) – Provides end-to-end solution

City of Philadelphia (public) – Operates waste collection and treatment, as well as operates installed sensors and solutions

XXX = Service operator

Case Study 3: Tampines Pasir Ris Singapore

Status & scale:
- Implemented in 2018
- Sensors installed at 52 bins at service fee of SGD 8 for high-rise buildings and SGD 28 for land homes

Service overview
- Operate sensors via cellular network
- Send alerts to the rubbish collector when bins are 3/4 full along with route optimization and optimal pick up schedule

Expected/ realized benefits
- **~50% reduction** in waste collection time due to optimization of route planning
- Expected reduction in number of refused collection trips
- Expected reduction in complaints on overfilling bins from residents

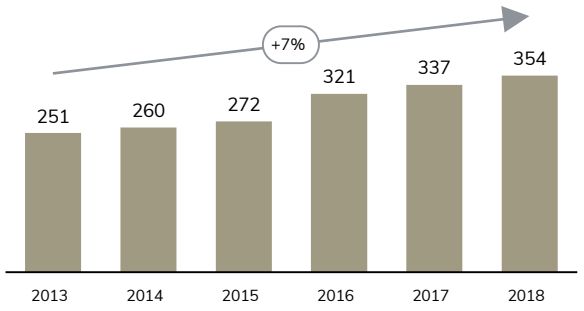
Relevant stakeholders
800 Super (public) – Operates waste collection and treatment, develops Smart Waste solution, performs route planning and optimizes service

XXX = Service operator

Service Relevance to Phuket

Smart Waste Management is relevant for city/ province that has high generated waste with insufficient infrastructures and capabilities to manage and treat waste properly. Smart Waste Management has high potential to support local Phuket governments to efficiently collect and treat waste generated by locals and tourists.

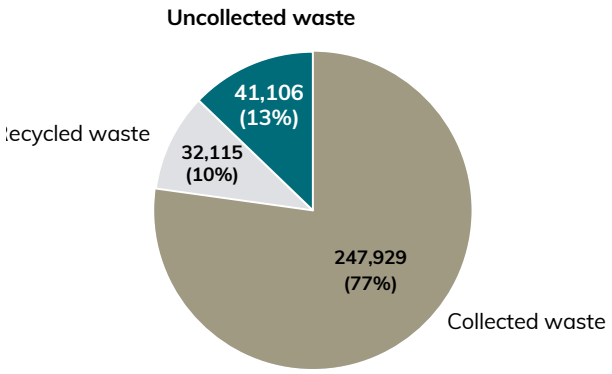
Generated waste per year ['000 tons]



Source: Phuket NSO

Generated waste in Phuket is projected to continuously increase due to growth of population and visited tourists which can be challenging for Phuket to properly collect and manage them in the long run. Generated waste in Phuket has increased by 7% over the past 6 years of which majority of generated waste do not get managed and treated properly. Phuket only has capacity to dispose 700 tons of waste per day and also does not have enough landfill to support leftover waste.

Generated waste per year [2016, tons]

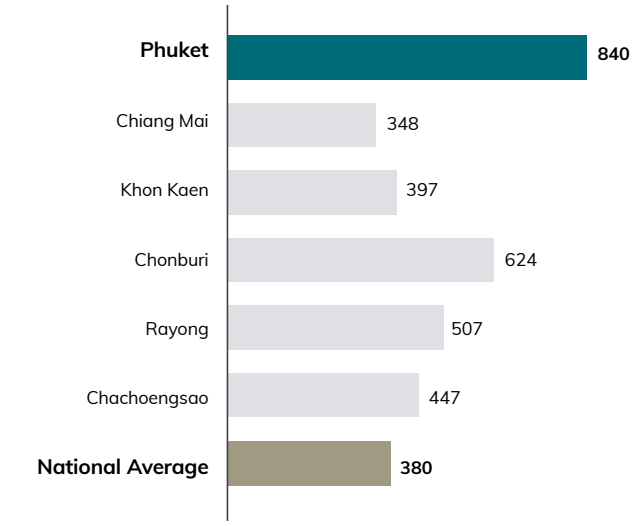


Source: Phuket NSO

In 2016, around 13% of total 2016 generated waste or 41,106 tons of waste were not collected and treated properly due to growth in population and tourists, and unsupported existing infrastructure such as limited landfill capacity and waste incineration plants. The waste pollution issues due to uncollected waste have been increasingly reported by local residents over the past years. Total reported case has increased from 22 cases in 2014 to 34 cases in 2016. Majority of cases were reported due to overfilling bin and air pollution from leftover waste.

Phuket currently generates large volume of waste as compared to other provinces and national average. Around 350,000 tons of waste were generated in 2018 which resulted in 840 kg of generated waste per capita per year

Annual generated waste per capita, 2018 [kg]



Source: Phuket NSO

Based on the current situation in Phuket, we believe that Smart Waste Management has strong potential to play important roles in supporting Phuket governments and other related parties to more efficiently manage and treat fast-growing generated waste.

We have formulated bottom-up market sizing to determine **full potential demand of number of installed sensors** in trash bins across Phuket to determine the attractiveness of this service in the long run. Based on current demographic and situation, Phuket has full potential to turn ~11,000 of waste collection points to support Smart Waste Management solution. Our bottom-up market sizing has been formulated based on **facts gathered** from public authorities in Phuket such as generated waste, number of households and percentage of urban households; and **assumptions** such as households per waste collection point, and adoption rate of Smart Waste Management solution.

Based on current demographic and situation, Phuket has full potential to turn

~11,000

of waste collection points to support Smart Waste Management solution.

Number of full potential demand was mainly derived from following items:

- Waste multiplier (mainly facts based) – Calculated based on waste generated in Phuket as compared to the national average to understand urgent needs of the service
- Number of waste collection point (facts and assumptions based) – Calculated based on number of households in urban areas and number of households per waste collection point
- Adoption rate of Smart Waste Management solution – Benchmarked with global case studies

If we are able to capture approximately 20% of full demand potential, our service coverage will already be larger than existing installed sensors of services launched in three above case studies. We believe that number of installed sensors at waste collection points will grow faster in later years due to the success proof-of-concept launch, realized benefits from the solutions and support initiatives from both public and private parties.

Service Readiness

We established the requisite infrastructure and regulations to determine readiness for a particular type of service. Requisite infrastructure and regulation refer to necessary equipment and/ or access for setting up the service in Phuket.

The most relevant infrastructure to support the launch of Smart Waste Management service is designated rubbish collection points. Some areas of Thailand do not have wide coverage of designated collection points for residents which result in putting trash bags in front of their houses. Without designated collection points, it will be challenging to install sensors to measure/ track trash levels for the system to perform route optimization and advance pick up schedule for the waste collector.

As of now, Phuket has designated collection points available in urban and high residential areas such as flats, hotels and villages,however, in some outer parts of Phuket, waste collection point is far away from residential area which reduce incentives to put trash in the designated collection point.

Based on the current situation of Phuket, Smart Waste Management can potentially be launched first in urban area to see the feasibility and benefits added to local stakeholders while local government adding more designated waste collection points to support future launch in outer areas of Phuket.

Other than infrastructure, we have also analyzed current regulations to understand whether this solution complies with current regulation or not to also determine the feasibility of the service. Currently, there is no regulation that will limit the launch of this service. Waste in Phuket is currently managed and treated by local governments such as Phuket and Patong municipalities, so in the case that the solution provider wants to be appointed in providing waste collection and operations along with their invented solution. The solution provider needs to obtain license/ approvals from relevant local stakeholders before launching the service. Moreover, the solution provider must follow the regulation/ guidelines formulated by local government and current authorized waste collector.

Key Stakeholders

Stakeholders for service set up and/ or operations – Public authorities that set up waste collection policies, develop waste collection facilities and operate waste collection services. Below figure shows the value chain of waste collection and treatment in Phuket.

> *"D-Kids is going to expand the service to recycling services as currently Phuket does not have enough landfill and waste incinerator capabilities to manage as-is waste level"*
>
> – Managing Director – D-Kids

Planned & Ongoing Initiatives

Stakeholders for service initiatives – Both public and private parties involves in the development of Smart Waste Management solution. Phuket currently has three ongoing Smart Waste Management initiatives to help support local governments to address waste related issues. All initiatives involve both private and public parties to carry out the initiatives:

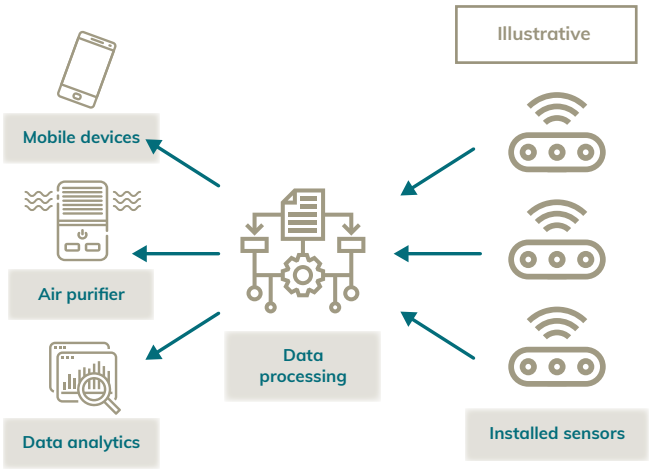
	Initiative description	Coverage/ investment	Benefits	Stakeholders
Initiative 1	> Ongoing – Started in 2017 > **D-Kids**, local SME, was awarded contract for rubbish collection from the local municipality and operates digital waste management system – Intelligent bins equipped with a sensor system that measures amount of waste in bins, as well as temperature and humidity	> THB 42 million contract from local municipality > Seeking THB 10 m loans from SME banks to purchase 7 additional garbage trucks	> 30% reduction of untreated waster in Patong area	**D-Kids** – Provides waste collection and operating system **Phuket Municipality** – Awards contract to D-Kids **CAT** – Provides connectivity and system
Initiative 2	> Ongoing – Started in 2017 > **Traffy Waste**, an application, developed by NECTEC to improve efficiency of waste collection to reduce the amount of uncollected rubbish in key areas > Only soft launch implemented	> Service coverage of **30 km²** across Patong and Phuket Municipalities	> Expected reduction of untreated waste > Expected reduction of operational cost for both Patong and Phuket Municipalities due to better route planning and optimal waste collection level	**NECTEC** – Provides R&D **SIPA** – Supports on stakeholder engagement **Patong Muni.** – Operates waste collection **Phuket Muni.** – Operates waste collection
Initiative 3	> Ongoing – Started in 2017 > **MoonFoi,** a startup platform for turning waste into cash for Phuket > Individuals can request recyclable waste collection through MoonFoi's website or MoonFoi's Facebook page – Within 24 hours, representatives would pick up the recyclable waste	> **THB 500,000 funding** received from depa's "Startup Challenge for Smart Cities" event in Phuket	> Expected waste reduction through provision of monetary incentives to those who recycle	**Moonfoi** – Develops and operates Smart Waste collection solution and applicationR&D **depa** – Supports on budget allocation and mentorship

XXX = Public stakeholder

SMART AIR QUALITY MONITORING

Service Overview

Function – Smart Air Quality Monitoring involves the use of installed sensors which can measure the level of pollutants such as CO_2, NO_2 and PM10, then sends real time data to the related service provider.



Benefit – The data can also be displayed via mobile application for civilians to avoid high pollutant areas. Data analytics can be used to further predict trends or identify causes of pollutants, to ensure maximum safety to the people in the area.

Another use for the data collected is to potentially activate any troubleshooting device, for instance, air purifying machines. The sensors can also be used to notify patrol staff of any possible incidents or outbreak of pollutants.

Smart Air Quality Monitoring is expected to give the local authority a better understanding of the level of pollutions in different areas during different times of the year. This will aid policy making, tackle pollution issues and identify root causes to ensure better living condition for inhabitants and visitors of the area.

Global Case Studies

Below are three case studies on Smart Air Quality Monitoring which have been implemented or are being implemented in major cities around the world. Taking these case studies as benchmarks, it is seen that the initiatives are often implemented under a collaborative effort between public and private sectors. The public sector usually provides funding and faciltates installation, whilst the private sector provides the technology and operational know-how.

Case Study 1: Paris, France

Status & scale:
- Implemented in 2018
- 30 next generation air quality sensors installed throughout the city

Service overview
- Provide six advanced air quality monitoring sensors, installed next to existing traditional sensors
- Provide additional 24 sensors, installed in areas of interests, hotspots and densely populated communities

Expected/ realized benefits
- More specific and efficient solution for tackling pollution problems due to identified pain points by government agencies and policymakers
- More accurate monitoring of pollution level by civilians, allowing in advance planning for their journey/ visits according to their health preference

Relevant stakeholders
- **Clarity (private)** – Provides and operates air quality monitoring sensors
- **Airparif (non-profit)** – Monitors air quality in Paris (accredited by the Ministry of Environment)
- **City of Paris (public)** – Overlooks the whole area of Paris

XXX = Service operator

Case Study 2: Seoul & 6 other major cities, South Korea

Status & scale:
- Implemented in 2017
- 1,500 sensors installed in major cities

Service overview
- Provide sensors installed both indoor and outdoor
- Carry out fine dust reduction activities via the installed platform, by interlocking with air purifiers, air conditioners and artificial rain drones

Expected/ realized benefits
- Increased support for government in formulating environmental policies, as a result of air quality data
- Expected expansion of sensors installation at nationwide infrastructure, including 4.5 million telephone poles, 330,000 mobile base stations, 60,000 public phone booths and 4,000 central offices

Relevant stakeholders
- **Korea Telecom (private)** – Provides and manages air quality monitoring system
- **Korea Central Government (public)** – Receives air pollution data and responds via policymaking and issuing preventive measures

XXX = Service operator

Case Study 3: London, UK

Status & scale:
- Implemented in 2018
- Commissioned by the City of London in 2019
- 4 boroughs in London currently covered

Service overview
- Collect pollutant data by recording levels of NO2, CO2 and PM2.5 in a number of areas including Vauxhall, Oval, Kennington and Elephant & Castle
- Measure safety level at 3 schools through the installation of stationary sensors

Expected/ realized benefits
- Increased support in policymaking for the local government officials
- Expanded coverage including other areas of London, especially the heavily congested areas

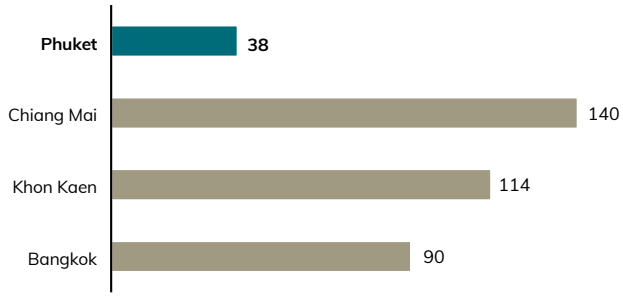
Relevant stakeholders
- **EDF (private)** – Provides related technology and overlooks monitoring processes
- **City of London (public)** – Overlooks the whole are of London and uses data for policymaking
- **Google (private)** – Provides Google Earth vehicles to attach sensors to

XXX = Service operator

Service Relevance to Phuket

Smart Air Quality Monitoring is relevant for city/ province that comprises of dense industrial facilities, congested traffic or frequent forest fires. In comparison to other major cities in Thailand, Phuket is facing relatively low air pollution due to low industrial activities and small local population. Therefore it can be said that tackling air pollution may not be the top priority for Phuket. However, the rapid increase in the number of tourists comes with rapid urbanization, making air pollution potentially athreat for Phuket in the future. It is in the interest of the Phuket cityto therefore be able to monitor air quality over the province fromtime to time, in order to make sure pollution level has not become a problem. Below is a comparison of the air quality index between Phuket, Bangkok, Chiang Mai and Khon Kaen, as well as the frequency of forest fire, a common cause for poor air quality

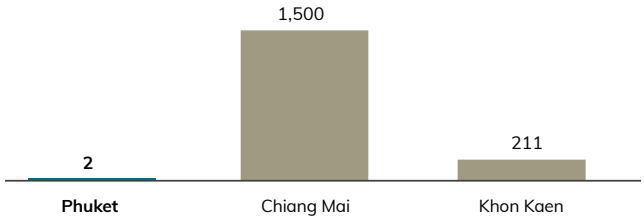
Air Pollution Index



Source: Phuket NSO

> *"Many industrial establishments in Phuket still lack the necessary knowhow and technology for pollution control. Environmental regulations must also be enforced more strictly in order to reduce pollution level"*
>
> – Deputy Chief – Department of Industrial Works (Phuket Provincial Office)

Average frequency of annual forest fires [times]



Source: Phuket NSO

We have formulated a bottom-up market sizing to determine full potential demand of number of installed sensors for air quality monitoring system across the province to determine the attractiveness of this service in the long run. Based on current demographic and situation, Phuket may benefit from installing 2 more sensors at other locations in Phuket, to make 3 sensors in total. Our bottom-up market sizing has been formulated based on data gathered from public authorities in Phuket such as the split between rural and urban areas; and assumptions such as concentration of sensors required to cover rural and urban areas, as well as the forest risk fire multiplier.

The requirement to install 2 further air quality sensors, at different areas of the province should not raise implementation nor budget issues for the Phuket City Authority. Air pollution monitoring may not be the prioritized smart imitative for Phuket, however, we believe that with low implementation cost and ease of operation, coupled with the fact that number of tourists is expected to rise, it may be beneficial for the authorities in charge to consider implementing the initiative in the future.

Phuket may benefit from installing 2 more sensors at other locations in Phuket, to make 3 sensors in total.

Service Readiness

After assessing the requirements for the installation of smart air quality monitoring, we have derived that the service is ready to be launched, if a decision to do so has been issued. This is because the regulations in Phuket do not forbid air quality sensors from being installed in public areas, which would be the ideal locations to monitor air quality anyway. However, in private locations like schools, the authority will need to seek approval from the institution before installing the sensors.

Key Stakeholders

Stakeholders for service set up and/ or operations – Public authorities monitor air quality, detect pollutants and manage the sources of the pollutants. The schematic below shows the value chain of the air quality monitoring process in Phuket.

	Monitor and manage sources of air pollution	Monitor general air quality and pollution level in major residential/commercial areas
Descriptions	> Monitor occurrence of forest fires > Control forest fires (once occurred) to minimize impact on citizen lives > Enforce standards to prevent forest fires > Monitor pollution from factories > Enforce standards to control pollution generated from factories > Issue/ withdraw operating licenses	> Monitor air quality/ pollution level > Report air quality/ pollution level to public > Report local complaints on pollution level to relevant authorities (no authority to deal with pollution sources)
Stakeholders	Department of National Parks, Wildlife and Plant Conservation Royal Forest Department Department of Industrial Works (Phuket Provincial Office)	Pollution Control Department

Planned & Ongoing Initiatives

Stakeholders for service initiatives – Air quality monitoring in Thailand normally involves only the public sector. Phuket currently has one smart air quality monitoring initiative to help support local governments to address any air pollution related issues. Although present, the initiative in Phuket is relatively inactive, with only 1 sensor in the province.

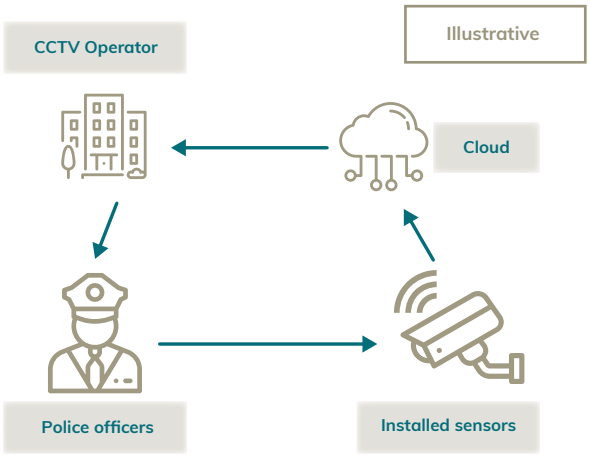
	Initiative description	Coverage/ investment	Benefits	Stakeholders
Initiative 1	> Ongoing > Air quality sensors installed at Municipal Health Center 1, only able to measure PM10, O_3 and CO	> Sensors only deployed at a single location (not representative of the whole province)	> Ability to notify pollutant level in city center area by local governments and civilians	**Phuket Municipality** – Equip sensors at municipal health center

XXX = Public stakeholder

INTEGRATED CCTV SYSTEM

Service Overview

Function – Integrated CCTV System leverages the large connected network of CCTVs along with the solution integration with the command center to collect real time information and provide instant alerts to responsible officers to address the situation. Integrated CCTV System provides facial recognition function and video analytics to analyze unusual behaviors while command center collects data to support instant warning and decision making.



Analogue CCTV has been replaced with integrated solution as it can send real time information to command center without requiring officers to retrieve files from the CCTV's memory card.

Benefit – Integrated CCTV System will provide benefits to both residents/ tourists and also the CCTV operator:

- Resident/ tourist – Integrated CCTV System enhances the safety as it helps identify immediate on-the-scene detection and provides alerts to the nearby police officer

- CCTV operator – The CCTV operator can experience cost saving from real time file retrieving. Moreover, the benefit of large CCTV network integrated with command center is that it allows the operator to enable fast decision making due to multiple sources of information directly linked to the command center and instant collaboration feature with other related parties to efficiently minimize loss and enhance safety of the city.policy making, tackle pollution issues and identify root causes to ensure better living condition for inhabitants and visitors of the area.

Below three global case studies demonstrate solution overview and realized/ expected benefits from this solution.

Global Case Studies

Below three case studies have shown the successful launch of Integrated CCTV System at the global level. Throughout below case studies, Integrated CCTV System development is initiated and operated by the public sector to enhance safety of the locals and tourist in the city. Integrated CCTV System has been developed along with the centralized command center in order to gain more visibility throughout the city.

Generally, solution developers are private parties where they support the public sector on the initial solution development, network setup and integration as well as integration of command center and CCTV.

Common benefits that three case studies have realized are reduced crime rates compared to previous years, faster immediate response between the CCTV operator and other related agencies such as police or firefighter and savings on operational cost as Integrated CCTV System allows the operator to remotely retrieve video files from the command center without deploying the officers to collect from memory cards of CCTVs and higher accessibility rate due to cloud based solution.

Below three cases have been selected as they are still active with some expansion plans in their pipelines. They have also provided proven/ tangible benefits in both short and long terms after the implementation.

Case Study 1: Anyang, South Korea

Status & scale:
- Implemented in 2008
- Full CCTV integration implemented across existing CCTVs throughout the city

Service overview
- Provide intelligence Integrated CCTV System to identify suspicious movement of residents and vehicles on the street
- Develop Smart City service mobile application for citizens to receive alarms or warnings sent by the operations center

Expected/ realized benefits
- **18% reduction** of total number of crime cases
- Quicker response and intervention to address the situation between the CCTV operator and police officer as well as other related agencies
- Generated area analysis to determine both high and low crime rate zones to support the officer in resource allocation

Relevant stakeholders

SC group **Smart City Initiator Group (private and public)** – Provides solutions and operating system interface for the operator

City of Anyang (public) – Operates Integrated CCTV System and sends alerts/ warnings to other agencies

XXX = Service operator

Case Study 2: Guaymas, Mexico

Status & scale:
- Implemented in 2018
- Service coverage in both high residential and port area of Guaymas

Service overview
- Operate Integrated CCTV System over the port to monitor the perimeter and help prevent the stealing of materials and potential drug trafficking
- Provide full service integration to allow officers to quickly access and review video records across connected CCTVs

Expected/ realized benefits
- Wider visibility of the port and city area, enabling security staffs to immediately respond to criminal activities
- Increased efficiency and performance with little latency supported by a strong integrated network of CCTV and command center

Relevant stakeholders

AVIGILON **Avigilon (private)** – Provides end-to-end integrated solution

Port of Guaymas (public) – Operates Integrated CCTV System and sends alerts/ warnings to other agencies

InfiNet **InFinet (private)** – Provides wireless connectivity platform

XXX = Service operator

Case Study 3: Shenzhen, China

Status & scale:
- Implemented in 2017
- City wide coverage with expansion plan to other cities planned by the central government

Service overview
- Provide real time monitoring and behavior tracking in public areas for the CCTV operator
- Formulate behavior prediction based on facial and behavioral reaction

Expected/ realized benefits
- **More than 2,000 suspects** identified over the past fewyears
- **800 people** arrested by police officers with over **100 cases** solved after the implementation
- Facial recognition to support missing people identification and location tracking from large connected network

Relevant stakeholders

MEGVII **Megvii (private)** – Provides AI facial recognition system

Public Security Bureaus of China (public) – Operates Integrated CCTV System and overlooks security alerts management

商汤 **SenseTime (private) –** Provides wireless connectivity platform

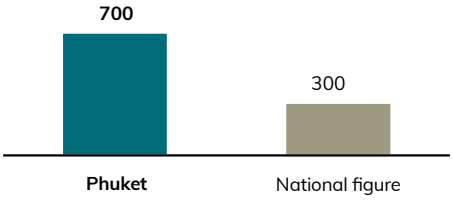
XXX = Service operator

Service Relevance to Phuket

Integrated CCTV is relevant for the city/ province that has low number of police officers available, high reported crime cases and large area coverage per CCTV. Currently, Phuket has around 2,000 CCTVs installed across the province. From as-is situation, we believe that Integrated CCTV has high potential to support the current CCTV operator in enhancing the service offerings and safety in Phuket.

Phuket has higher number of population to a police officer as compared to the national figure.

Ratio of population to total number of police officers, 2017-2018

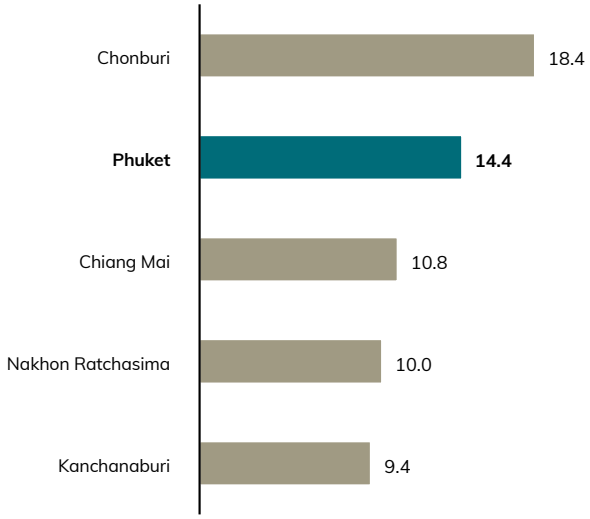


Source: Royal Thai Police

Phuket has around 600 police officers which contributes to around 700 people per one police officer. This can be challenging for the police officer to address issues across the city. Integrated CCTV System can potentially address this solution by providing real time monitoring of different areas in Phuket in which the police officer can be sent to check on the area if unusual behavior has been detected.

Phuket still has low number of CCTVs per unit area with approximately 10 CCTVs per sq km. This is still very limited to provide standardized safety across the province. In comparison with London, Phuket's number of CCTVs per unit area is around three times smaller than London's figure, and all of London's CCTVs are also fully integrated into one single command center, allowing the operator to obtain the full visibility of the city.

Number of visitors in Top 5 provinces (excluding Bangkok), 2018 [# m]



Source: Ministry of Tourism and Sports

As Phuket is considered as one of the top global destinations in the world, it generally attracts a vast amount of visitors every year. In 2018, Phuket has attracted approximately 14 million visitors in total. This is considered the second highest out of all provinces (excluding Bangkok) and also accounts for about 5% of total visitors in Thailand that year.

Based on the current situation in Phuket, we believe that Integrated CCTV System has strong potential to play important roles in supporting Phuket governments, existing CCTV operators and other related parties to enhance safety across the province.

We have formulated bottom-up market sizing to determine **full potential demand of number of integrated CCTVs** across Phuket to determine the attractiveness of this service in the long run. Based on the current situation, Phuket has full potential to develop Integrated CCTV System across ~9,000 CCTV points from both existing and newly installed CCTVs. Our bottom-up market sizing has been formulated based on facts gathered from public authorities and desktop research such as number of CCTVs, and number of tourist per year; and assumptions such as additional number of CCTVs to be installed, percentage of connected CCTV for both existing and new CCTVs.

Number of full potential demand was mainly derived from following items:

- Tourist multiplier (mainly facts based) – Calculated based on visited tourists in Phuket as compared to the national average to understand urgent needs of the service
- Additional number of CCTVs (assumptions based) – Calculated based on number of expected CCTVs to increase coverage per sq km
- Penetration of connected/ integrated solution (assumption based) – Calculated based on the likelihood of integrating CCTVs into one single network across new and existing CCTVs in Phuket

If we are able to capture around 30% of full demand potential, our fully-integrated network of CCTVs will be greater than the existing number of available CCTVs in Phuket. We believe that number of integrated CCTVs will grow faster in later years due to the success of proof-of-concept launch, realized benefits from the solutions and increased supports from both public and private parties.

Phuket has full potential to develop Integrated CCTV System across

~9,000

CCTV points from both existing and newly installed CCTVs.

Service Readiness

We have assessed the required infrastructure and regulations to determine the readiness of Phuket to launch Integrated CCTV System service.

There are two key relevant infrastructures that can potentially determine the successful launch of Integrated CCTV System in Phuket.

- Province wide connectivity – To help assess if the current connectivity can support the full integration network between CCTVs and command center to provide full service potential to the CCTV operator and other related parties
- Existing CCTVs – To help understand if Phuket has existing number of CCTVs to support the quick launch and scalability of the service in both short and long terms

From the assessment of above infrastructures, we believe that Integrated CCTV System can be launched at throughout the city as Phuket has strong coverage of connectivity. Integrated CCTV System can potentially be roll out first in city areas as there are approximately 2,000 CCTVs available that can be turned into integrated and connected CCTV network to test the service feasibility and identify operational gaps prior to the service extension.

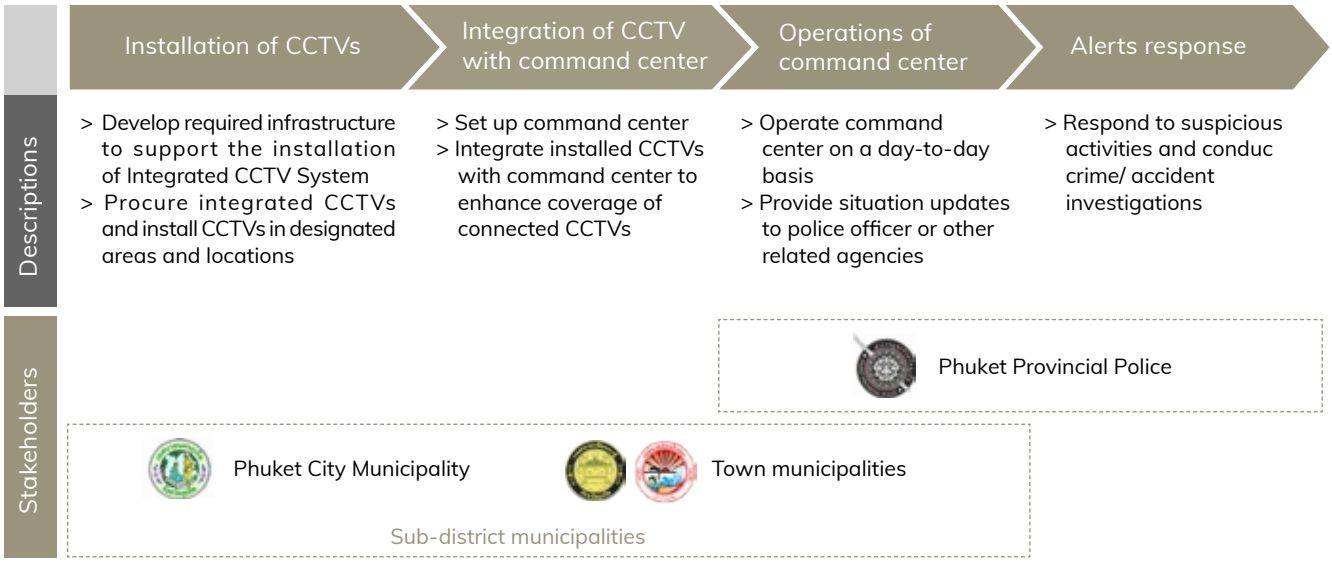
Other than infrastructures, we have also analyzed current regulations to understand whether this solution complies with current regulation or not to also determine the feasibility of the service. Currently, there is no regulation that will limit the launch of this service, however the permission/ approval is still required prior to modifying or installing new CCTVs on the existing infrastructure/ or other government assets/ properties. The CCTV operator must also ensure that installed CCTVs will not invade privacy of residents as some CCTVs can record wide areas which cover private areas.

The authorized CCTV operators are municipalities across different city areas, therefore the solution developer is required to strictly follow rules/ guidelines established by the government at both national andmicro levels.

> *"We are currently operating over 100 CCTVs and they are integrated into our command center; The crime rate in the province has been reduced after the project implemented. We are looking to expand our service coverage across important areas such as school, hospital areas, etc."*
>
> – Deputy Mayor –
> Kathu Town Municipality

Key Stakeholders

Stakeholders for service set up and/ or operations – Public authorities that are responsible for CCTV network roll out, network integration, operations and alert response, etc. Below figure shows the value chain of Integrated CCTV System operations and alert management in Phuket.



Planned & Ongoing Initiatives

Stakeholders for service initiatives – Both public and private parties involved in the development of Integrated CCTV solution. Phuket currently has one initiative to help enhance CCTV network for CCTV operator in Phuket. This initiative involves both private and public parties to carry out the initiative:

	Initiative description	Coverage/ investment	Benefits	Stakeholders
Initiative 1	> Ongoing with service expansion plan > **Hitachi**'s solution aims to reduce blind spots and allow faster responses to emergency via installation of more CCTVs and connection of all CCTVs in Phuket to centralized security command center – Intelligent CCTV with facial recognition system to assist in investigation and suspect pursuing (integrated with police database on criminals, allowing detection of criminals on cameras)	> Potential CCTV installation expansion to around **4,000 CCTVs** > Below **1,000 CCTVs** are linked to the command center > Plans to connect all installed CCTVs with command center	> Live image from CCTV as well as immediate alerts from anomalous movement > Faster response to emergency for police officer	**Hitachi** – Provides analytics system to identify suspicious behaviors **Phuket Municipality** – Equip sensors at municipal health center **Royal Thai Police** – Operates cameras and command center **depa** – Provides technological and advisory support XXX = Public stakeholder

SMART DISASTER WARNING & ALERT SYSTEM

Service Overview

Function – Smart Disaster Warning & Alert System involves the utilization of environmental sensors to monitor and predict any environmental changes that could lead to natural disasters such as flooding, storm, landslide, earthquake, Tsunamis, forest fire, etc. The service has the main objective of preventing lives from such events by quickly issuing alerts, warnings and preemptive responses very well in advance, so that any losses and damages from these events could be avoided as much as possible

Illustrative

Smart Disaster Warning & Alert System service generally comes in a platform with three main components operating together collectively:

- Sensors/ detectors – Monitor environmental changes and transmit data directly to the central control system
- Central control system – Process and analyze detected data, leveraging historical data and computerized algorithms to formulate appropriate announcement for disaster relief
- Information distribution channels – Distribute announcement to the general public in form of alerts and/ or warnings, via channels such as digital signage and mobile application

Benefit – Smart Disaster Warning & Alert System service helps naturally risk prone cities by mitigating losses caused by natural disasters. The service makes environmental predictions and forecasts in advance which allow for the generation of early warnings. This provides high lead time for locals to be anticipated and prepare for upcoming disastrous events, and hence reduce both physical and financial losses in the long run.

Global Case Studies

The three examples below illustrate successful case studies for Smart Disaster Warning & Alert System which have been launched around the world. In most cases, a well-established physical centralized control unit has previously been launched as a direct initiative in order to respond to recent natural disasters that resulted in substantial losses within their respective cities.

Generally, a centralized control unit is often operated by public sector authorities in each city, leveraging technological insights/ knowhow, as well as both software and hardware provided by multinational technology companies. Collaborations with both governmental departments and other related state agencies are also very crucial as they providereal time environmental data which will be used for further analyses in order to issue suitable preemptive responses.

Case Study 1: The Philippines (nationwide)

Status & scale:
- Implemented in 2012
- Almost 2,000 sensors that stream environmental data every 15 minutes installed all over the country
- High resolution flood, storm and landslide maps available for 70% of entire country

Service overview
- Provide disaster management platform, which is accessible by public through both web and mobile application, that brings together real time information from satellite data, doppler data, sensors, as well as historical weather and disaster information
- Combine science and technology for disaster risk reduction and management, aiming to provide high leadtime warning for prevention and mitigation purposes
- Provide interactive map in which users can add various layers to further highlight relevant natural hazards within areas of choices

Expected/ realized benefits
- **Up-to-6-hour lead time** warning and announcement in case of anticipated natural disasters
- **Millions of lives** saved from past storm surges due to efficient evacuations resulting from 3 hours in advance early warnings

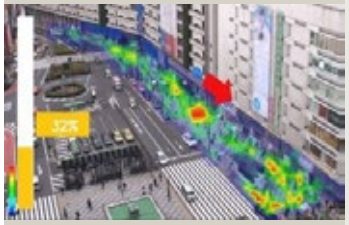
Relevant stakeholders

University of the Philippines (public) – Operates platform and provides funding for necessary investment

Department of Science and Technology (public) – Conducts research, develops both web and mobile application platforms and provides related environmental data through the help of their various service agencies and institutions

XXX = Service operator

Case Study 2: Toshima, Japan



Status & scale:
- Implemented in 2015
- Over 50 disaster prevention cameras strategically installed around emergency relief centers

Service overview
- Leverage crowd behavior analysis technology that analyzes changes in crowd behavior obtained from disaster prevention camera footages to detect any abnormalities
- Provide disaster response centers with real time information to assist in decision making and formulate suitable countermeasures

Expected/ realized benefits
- Improved response time in issuing appropriate measures due to real time information collected from disaster prevention cameras

Relevant stakeholders

NEC (private) – Provides end-to-end solution

Toshima City Office (public) – Operates solution and collects generated data for further optimization

XXX = Service operator

Case Study 3: Rio de Janeiro, Brazil

Status & scale:
- Implemented in 2011
- Over 400 employees working in shifts 24/7
- Integrated information and data from 50 city agencies

Service overview
- Analyze real time data from rain gauges, radar sensors, GPS system, and from other state agencies with help from IBM's analytical models to predict and coordinate responses to emergency incidents
- Provide maps of areas at risk to flooding and landslide, as well as evacuation system to deal with extreme conditions
- Provide public with real time data accessible through mobile application and social networks

Expected/ realized benefits
- Expected significant reduction in reaction times to emergency situations due to instantaneous mobile communications, including automated email notifications and instant messaging

Relevant stakeholders

IBM (private) – Provides end-to-end solution

Rio de Janeiro City Hall (public) – Operates operations center and collects generated data for further optimization

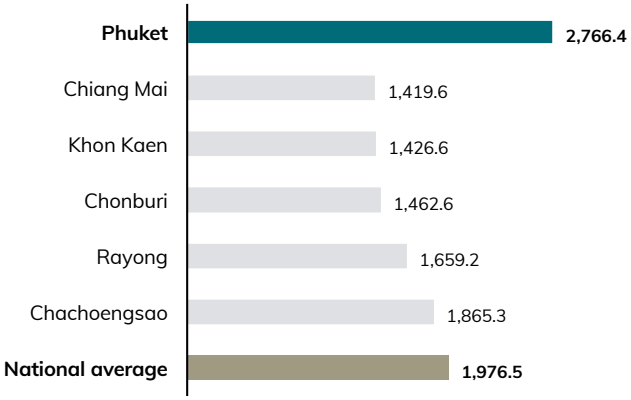
Other related city agencies (public) – Provide real time data

XXX = Service operator

Service Relevance to Phuket

Smart Disaster Warning & Alert System is relevant for city province which is generally prone to natural disasters such as flooding, landslide, earthquake and Tsunami. Risk of flooding is mostly related and is governed by the amount of rainfall city has experienced and drainage management system. For landslide, main causes are seismic activities especially on areas with steep slopes and heavy rainfall especially when soil contains excessive amount of water. On the other hand, earthquake and Tsunami are completely dependent on seismic activities. In order to understand the relevance of Smart Disaster Warning & Alert System to the city/ province, the aforementioned factors must be taken into account as these disastrous events are heavily dependent on them.

Annual rainfall, 2017 [mm]

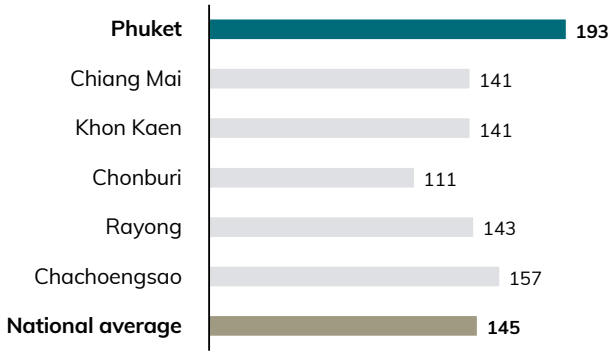


Source: Thai Meteorological Department

In 2017, the amount of annual rainfall in Phuket was **2,766.4 mm.**

> *"We are currently operating 19 sensor points across the province to support disaster alerts; Our team is capable to further develop solutions that provides security coverage across different areas"*
>
> – Chief –
> Phuket Provincial Office of the Department of Disaster Prevention and Mitigation

Number of rainy days, 2017 [mm]



Source: Thai Meteorological Department

Phuket has a high risk of flooding due to the heavy rainfall experienced. In 2017, the amount of annual rainfall in Phuket was 2,766.4 mm. This is considered a very high figure when compared to other provinces and is also approximately 40% higher than the figure for national average of 1976.5 mm in the same year. On the other hand, Phuket also has very high number of rainy days within a year, with 193 days considered to be rainy in 2017. This figure is one of the highest in the country, exceedingthe national average of 145 days. The main cause for frequent heavy rainfall is mostly due to the fact that Phuket, situated on the West coast of Southern Thailand, directly receives the Southwest monsoon which normally blows in from the Indian Ocean between June and September.

Phuket poses a reasonable amount of risk of landslide due to the fact that about 70% of total area is covered in mountainous terrain, as well as high annual rainfall level. In total, there are 18 areas across the province which have been considered to be highly prone areas according to the Phuket Provincial Office of the Department of Disaster Prevention and Mitigation.

Phuket also has a very high risk of experiencing earthquakes with likelihood for Tsunami. This is because Phuket's location is situated within the proximity of the tectonic boundary between Eurasian and Indo-Australian plates. Therefore, Phuket will be very prone to earthquakes if plate collisions occur. An example of this was the high magnitude Indian Ocean earthquake that happened in 2004, resulting in Tsunami hitting the Andaman coast and causing over 5,000 deaths

With the facts mentioned above taken into consideration, we believe that Smart Disaster Warning & Alert System is highly relevant to Phuket as it will surely play an important role in mitigating losses caused by natural hazards, especially those from flooding and earthquake.

> *"We are in collaboration with Department of Disaster Prevention and Mitigation to develop Smart Disaster Warning solution, and is currently seeking budget to set up additional 9 sensor points in Phuket"*
>
> – Executive Director– Andaman Environment and Natural Disaster Research Center

Service Readiness

We established the requisite infrastructure and regulations to determine readiness for a particular type of service. Requisite infrastructure and regulation refer to necessary equipment and/ or access for setting up the service in Phuket Successful Smart Disaster Warning & Alert System deployment relies significantly on strong network of internet to ensure stable connections and smooth operations between all components within the ecosystem, namely sensors/ detectors, central control system and information distribution channels. This is crucial for Smart Disaster Warning & Alert System since up-to-date and real time data are necessary in order to anticipate and issue warnings with enough lead time in case of emergencies. Delays in data could prove to be very dangerous as the early the alerts and warnings are announced, the higher the number of lives that could be saved due to earlier evacuations from the affecting areas.

Based on the current situation, Phuket's necessary infrastructures are more than ready to support the launch of Smart Disaster Warning & Alert System. This is because WiFi points are currently available throughout strategically important areas within the city, with the local government also granting a significant amount of budget to support the installation of at least 1,000 additional Wi-Fi points throughout the city.

Data management is also a key factor for successful deployment. In order to achieve effective operation, it is necessary for all related state agencies to be very transparent when it comes to sharing their operational data. This means that obtaining full alignment and cooperation from them will be necessary as well.

In terms of regulations, there is currently no significant barriers that would adversely affect the successful deployment of the service in both short and long terms. However, solution provider will need to obtain permissions from relevant provincial offices prior to installing environmental sensors.

Key Stakeholders

Stakeholders for service set up and/ or operations — Public and private parties that will be involved in the setting up and deployment of Smart Disaster Warning & Alert System

	Sensors/ detectors installation	Equipment maintenance	Data monitoring and analyses	Alerts/ warnings announcement	Disaster response
Descriptions	> Set up and install relevant sensors/ detectors at strategically important locations	> Perform regular check ups > Repair and/ or replace any necessary devices	> Monitor data on environmental changes via installed equipment > Collect all necessary data for further analyses	> Issue alerts and warnings to the general public through various channels with enough lead time	> Coordinate and execute mitigation plan before disaster > Support citizens with appropriate measures after disaster
Stakeholders	Phuket Royal Irrigation Project Provincial Office for Natural Resources and Environment Phuket Water Resources Regional Office 10 Solution provider			Phuket Royal Irrigation Project Phuket Provincial Office of the Department of Disaster Prevention and Mitigation Phuket City Municipality Town municipalities Sub-district municipalities	

Planned & Ongoing Initiatives

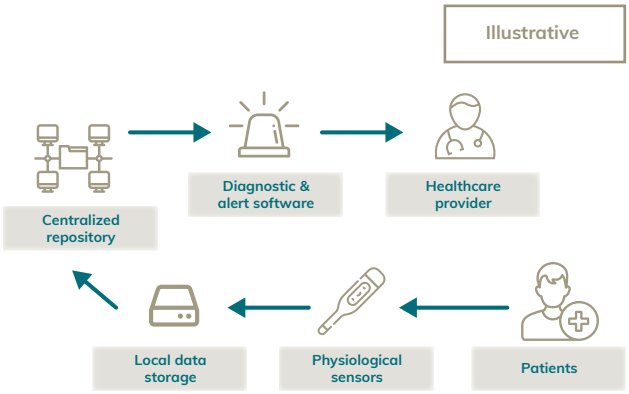
Stakeholders for service initiatives – Public and private parties that will be involved in the development and deployment of currently available Smart Disaster Warning & Alert System in Phuket. Phuket currently has only one ongoing Smart Disaster Warning & Alert System initiative to help support the local government in traffic related issues.

	Initiative description	Coverage/ investment	Benefits	Stakeholders
Initiative 1	> Ongoing – Started in 2017 > Sensors detecting suspicious environmental changes > Sensors with ability to: – Monitor water quality and level – Monitor rainfall level – Monitor air quality > Intelligence Operations Center (IOC) analyzing ambient information collected by sensors to predict natural disasters	> 14 environmental monitoring sensors installed along 8 km of Bang Yai Canal	> Officers at IOC to issue alerts and warnings to tourists and citizens according to the detected data suggesting suspicious weather and water level changes	**Digital Economy Promotion Agency (depa)** – Provides technological and advisory support **Phuket Provincial Police** – Operates IOC that receives data from sensors and issue alerts for potential disasters XXX = Public stakeholder

REMOTE PATIENT MONITORING

Service Overview

Function – Remote Patient Monitoring provides the monitoring and tracking of the condition of patients outside of conventional clinical settings, i.e., at home, to maintain independence of patients, prevent complications andminimize personal costs. Remote Patient Monitoring usually consists of 4 different components:



- Sensors enabled by wireless communication, measuring physiological parameters (blood pressure and glucose level)
- Local data storage system at patient's site
- Centralized repository to store and process data
- Diagnostic application software to give treatment recommendations or send alerts to healthcare providers

Depending on the illness, the configuration of the monitoring system may vary (e.g. diabetic patients would focus more on blood glucose sensors)

Benefit – Remote Patient Monitoring saves commuting time, increases access to healthcare in remote areas, decreases healthcare delivery costs and improves patients' quality of life, especially for those with chronic diseases. The time and money saved from using Remote Patient Monitoring will allow doctors to selectively attend those who really need physical health or are in critical conditions.

Global Case Studies

Below are the three case studies on Remote Patient Monitoring which have been implemented or are being implemented in major cities around the world. Taking these as benchmarks, it is seen that the initiative is usually implemented under a collaborative effort between universities, research institutes and large pharmaceutical or healthcare groups. The research institutes/ universities provide the technology, whereas the healthcare companies provide project funding and market products.

Case Study 1: Singapore

Status & scale:
- Implemented in 2017
- Service coverage throughout Singapore

Service overview
- Provide wearable/ medical devices that collect relevant health parameters as data and send to a gateway (home router) using proximity (short range) communication protocols such as Wi-Fi, BLE, RFID, etc.
- Provide solution deployed on TCS's IoT platform, known as TCS Connected Universe Platform as well as provide other services such as sensor device management, data acquisition and storage and data analytics

Expected/ realized benefits
- Less pressure on nursing homes for Singapore's administration
- **Up to 63%** expected reduction in hospital admissions
- Ability for caregivers to remotely watch over elderlies by providing non-intrusive regular monitoring through in-home sensors that collect and compare data on elderlies' routine, based on a pre-determined profile

Relevant stakeholders

Tata Consultancy Services TCS (private) – Provides required technology and operates the service

Singapore Management University (academia) – Conducts researches

Government of Singapore (public)

XXX = Service operator

Case Study 2: Phoenix, USA

Status & scale:
- Implemented in 2011
- Ongoing with constant development and expansion into wider range of physiological parameters

Service overview
- Provide heart failure remote monitoring program initially before expanding to cover a wider range of illness
- Utilize 3G/ 4G mobile broadband with connected homeuse medical devices to enable nursing care coordinators to remotely monitor patients
- Cover patients with other chronic or high-risk conditions such as sepsis (blood poisoning from infection)

Expected/ realized benefits
- **44% reduction** in number of patients readmitted to emergency department six months following enrollment
- **64% fewer days** hospitalized on average six months following enrollment
- **USD 92,000 reduction** in average cost per patient for hospital six months following enrollment

Relevant stakeholders

Qualcomm Life, Inc. (private) – Provides technology and operates service

The University of Arizona (academia) – Conducts research and development

Northern Arizona Healthcare Foundation (public) – Oversees the healthcare practice in Northern Arizona

XXX = Service operator

Case Study 3: NHS Highlands, Scotland (UK)

Status & scale:

- Implemented in 2018
- Currently in use at Caithness General Hospital under the NHS

Service overview

- Provide hospital bed tracking system, using Bluetooth tags to transfer real time data via a low-power, wide area Internet of Things (IoT) network called LoRaWAN, allowing medical staff to see where beds are
- Provide tags attachable to hospital beds, allowing them to share location and maintenance information with a dashboard monitored by NHS personnel

Expected/ realized benefits

- Improved hospital bed usage efficiency
- Real time data on how patients and staffs use its buildings and equipment in order to help health service to effectively manage its UK-wide estate and assets

Relevant stakeholders

Caithness General Hospital (public) – Oversees monitoring and operation of the initiative

Beringar (private) – Provides technology

CENSIS, the Scottish Innovation Centre for Sensor and Imaging Systems (public) – Conducts research and development

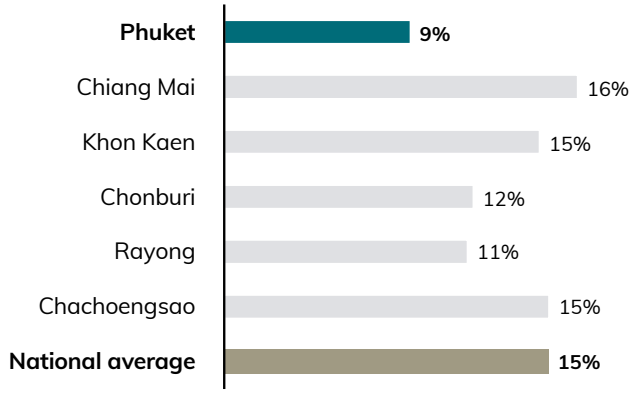
XXX = Service operator

Service Relevance to Phuket

The relevance and demand of Remote Patient Monitoring at any locations are primarily dependent on four key areas. These include population of elderlies within the area, number of elderlies living alone, prevalence of chronic illness and finally number of private hospitals within the area.

Population of elderlies is arguably the most important dimension when determining the relevance and demand of Remote Patient Monitoring. The definition of elderlies in this case is defined as those who are older than 60 years of age. In 2017, elderlies account for about 9% of the total population of Phuket. When compared to other major cities in Thailand, this figure is far lower. The figure for Phuket is also lower than the national average value of 15% which suggests that the demand for Remote Patient Monitoring service could be moderate to low.

Percentage of elderlies, 2017 [%]



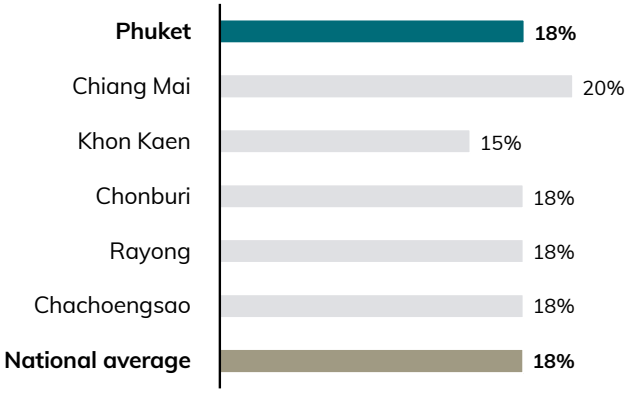
Source: Department of Older Persons

> *"The goal here is to reach a state of "Smart Home", putting smart wristband on both in- and outpatients to monitor their vitals in real time"*
>
> – Assistant Hospital Director– Bangkok Hospital Phuket

> *"We are currently working on the initiative to enable staff to locate patients and keep track of medication record as well as for doctors to monitor the patient's vitals"*
>
> – Assistant Hospital Director– Bangkok Hospital Phuket

By going one step deeper, elderlies are also categorized into those living alone and those living with another elderly. These people are the primary target of the Remote Patient Monitoring service as they have no one, but only their elderly partner to closely monitor them. This group is approximated as 18% of the total population of elderlies and is also with the national average figure too.

Percentage of elderlies living alone or with another elderly, 2017 [%]



Source: Department of Older Persons

The two major chronic illnesses which Remote Patient Monitoring would benefit are diabetes and injuries/ conditions of the elderlies who have fallen in the past. For diabetic elderlies, the number is very low in Phuket, with only around 1% of the elderly inhabitants suffering from the disease. This is considered low compared to the national average of 7.3%. Proportion of elderlies who have fallen and suffered the aftermath of the incident, e.g. inability to walk normally, in Phuket is 13% of total elderlies population. This figure is slightly higher than the national average 12%.

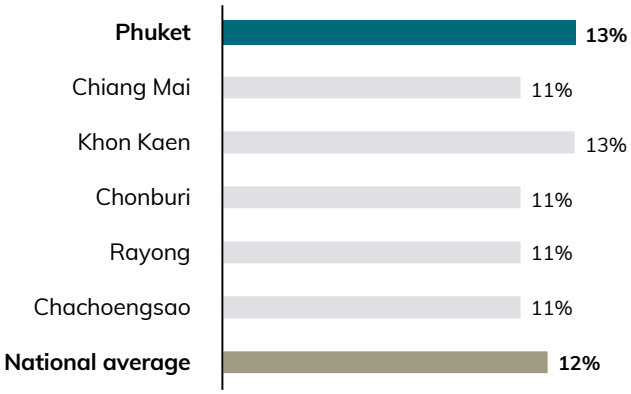
The total consumption in Phuket
We have estimated a demand of up to

750

patients

who may require this service in Phuket.

Percentage of elderlies who have fallen down at least once, 2017 [%]



Source: Department of Older Persons

Number of private hospitals in the city/ province is another important dimension as private hospitals patients often have higher ability and more likelihood to pay for Remote Patient Monitoring service. In Phuket, private hospitals are only located in the urban area with 3 private hospitals in Mueang Phuket District. On the other hand, there are also various small health promoting hospitals and clinics spread out through the non-urban area.

Considering the 4 dimensions explained previously is useful, however the shear volume also needs to be taken into account. Phuket is a relatively small city with only around 400,000 inhabitants. Therefore, considering that the percentage of elderlies in Phuket is lower than national average and the number of elderlies with chronic illness or living alone are aligned with the national average, Phuket's demand for Remote Patient Monitoring is only moderate. We have estimated **a demand of up to 750 patients** who may require this service in Phuket. This was derived from the figures mentioned previously in this section. However, considering that partnership opportunity is mainly limited to the 3 major private hospitals in the urban district, the initiative will only be attractive if launched in partnership with large hospital groups at multiple hospitals across many provinces. Potentially, the service can start in Phuket but then expand to other provinces once benefits from launching pilot project are fully aware and realized by the general public.

Service Readiness

Two regulatory issues, Liability and Data privacy, pertain to offering Remote Patient Monitoring. Liability can act as a barrier for medical personnel who may promote and offer Remote Patient Monitoring. The Unsafe Goods Liability Act 2008 (Product Liability Act) was designed to protect consumers who incur damage from defective products by imposing strict liability on business operators involved in both the manufacturing and sale of products. Doctors who promote and sell remote monitoring devices may be subjected to liability should defective devices result in harm. However, plaintiffs, e.g. patients, who suffer injuries from defective medical devices would typically pursue product liability action against manufacturers rather than medical personnel or entities.

To conclude, although there are regulatory barriers, these are not significant nor direct enough to adversely affect the successful implementation of providing Remote Patient Monitoring service in the city of Phuket. The only other requirement that needs to be satisfied is for the patient's home to be equipped with internet connection, even if not currently present, there should be no problem with regards to installation.

Key Stakeholders

Stakeholders for service set up and/ or operations – For Remote Patient Monitoring, the responsibilities are decentralized in the sense that the government does not intervene with the initiative, except only in the regulatory areas. The key stakeholders are likely to be large private hospitals, who install, provide and maintain the service.

	Service installation, monitoring & maintenance		Regulations setup
Descriptions	> Install monitoring device with patient, at the hospital or patient's home > Monitor conditions of patient remotely > Provide guidance and support on how to use the device	> Receive alert if patient's conditions turn critical > Act and solve the issues accordingly > Look after the maintenance of the device	> Set regulations in order to ensure patient's safety
Stakeholders	Bangkok Dusit Medical Services Group (BDMS)		Ministry of Public Health

Planned & Ongoing Initiatives

Stakeholders for service initiatives – Only private stakeholders are predominantly involved in the provision of Remote Patient Monitoring. It has been reported that Bangkok Hospital Phuket (BDMS) has provided the service, but only in an ad-hoc manner, with no full-fledged service launched.

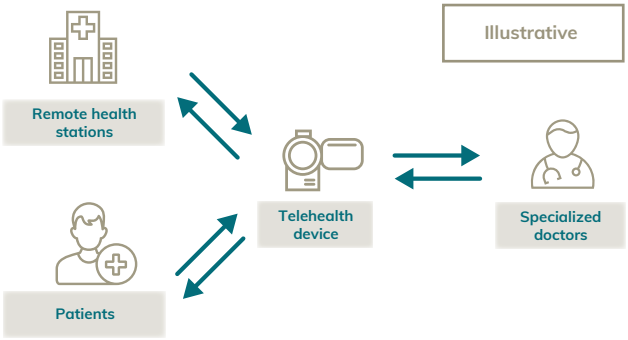
	Initiative description	Coverage/ investment	Benefits	Stakeholders
Initiative 1	> Only ad-hoc solution/ pilot launched (no full service launched)	> Information not available	> Ability to remotely monitor patients' conditions by a small number of private hospitals	**BDMS** – Provides required technology and operates the service

XXX = Public stakeholder

TELEHEALTH

Service Overview

Function – Telehealth supports/ promotes long distance clinical healthcare through telecommunication devices and technologies such as video conferencing. There are two main types of telehealth currently being implemented in full-scale around the world. The first is the connection between specialized doctors in large hospitals with health stations in remote areas, which are only staffed with nurses. The second is a direct communication between doctors and patients living far away from the hospital.



Telehealth, on a basic level, consists of regular video conferencing devices such as microphone, video camera and screen, while healthcare specialists communicate with patients. This is the most common format being used around the world at the moment. A more advanced format would consist of robotic diagnostic tools or even operational robots, whereby healthcare specialists would remotely control the robots from afar in order to diagnose or operate patients in remote areas.

In the context of Thailand, specifically in Phuket, Telehealth is likely to take the form of video conference communication between a specialized doctor in a large hospital with local health stations, run by general practitioners and nurses, which exist within the proximity of most rural communities

Benefit – The main benefit of Telehealth is its ability to offer medical care from specialists to patients in rural areas, who would not otherwise be available. Telehealth can also save healthcare providers time and transportation costs and thus improving the efficiency of the service.

Global Case Studies

Below are the three case studies on Telehealth which have been implemented or are being implemented in major cities around the world. Taking these case studies as benchmarks, it is seen that the initiative is usually implemented under a collaborative effort between the public sector and large hospital groups. Large hospital groups provide healthcare services, while government agencies ensure that necessary infrastructures are available for the communication to be established.

Case Study 1: Singapore

Status & scale:

- Implemented in 2017
- Service implemented at 9 major hospitals and 31 community care partners

Service overview

- Provide service for patients through the use of their own mobile devices or laptops with webcam to connect with their care team over the internet
- Enable multi-party high definition video and audio quality, as well as document sharing and annotation to facilitate interaction between patients and their healthcare team
- Provide end-to-end encryption for every single virtual session to enable protection based on banking industry standards and proven technologies

Expected/ realized benefits

- Waiting time in long queues saved by hours
- Reduced travelling expenses and enhanced service productivity as medical team is able to care for more patients in a given amount of time due to the fact that sessions are conducted remotely without the need of travelling around

Relevant stakeholders

Integrated Health Information Systems, IHiS (public) – Provides required technology

Major hospitals and community care partners – Operates the service

XXX = Service operator

Case Study 2: Tokyo, Japan

Status & scale:

- Implemented in 2017
- Service currently in use at Showa University Hospital and Showa Koto Toyosu Hospital

Service overview

- Communicate with bedside caregivers via live video link to continuously monitor patient status and remotely advise the best course of treatment
- Employ smart algorithms that predict deteriorations in health condition standards and proven technologies

Expected/ realized benefits

- Improved efficiency in medicine through a subsidy program for global innovation centers funded by the Japanese government to bring technology advancements to healthcare
- Increased profitability with enhanced patient flow and capacity management across the system
- **21% increase** in ICU case volume without adding additional beds or costs
- **20% reduction** in mortality from ICU monitored areas
- **30% reduction** in ICU patient's length of stay
- **~USD 1,500 cost savings** per patient across a 60-day post ICU period

Relevant stakeholders

Royal Philips (private) – Technology provider

Showa University Hospital (public) – University hospital, implementing the initiative

Showa Koto Toyosu Hospital (public) – University hospital, implementing the initiative

XXX = Service operator

Case Study 3: Singapore

Status & scale:

- Implemented in 2017
- Service currently in use at 10 hospitals in Singapore and also a number of other health centers

Service overview

- Enable patients to undergo physical rehabilitation exercises at any time and location, through the use of wearable sensors and remote monitoring by therapists
- Provide exercise bands along with wearable sensors for patients to carry out prescribed exercises with video demonstrations, instructions and indicators on a tablet
- Provide immediate feedback to patients on whether the exercises are correctly performed or not, i.e., if the desired exercise angles are achieved
- Provide video conferencing feature for patients to consult therapists remotely
- Provide highly accurate sensors and specialized algorithms to measure patients' performance and compliance which can also be reviewed by therapists asynchronously from the smart metrics dashboard

Expected/ realized benefits

- Improved patients' access to rehabilitation services, with the convenience and ease of doing rehab exercises from the comfort of their home
- Reduced waiting time and travelling cost by addressing the challenges of patients with mobility issues
- Improved operational efficiency due to the reduced travelling time by therapists – Resources could be better allocated to treat more patients

Relevant stakeholders

Integrated Health Information Systems, IHiS (public) – Provides required technology

National University of Singapore (academia) – Provides research and technology

Major hospitals and health center

Major hospitals and health centers – Operates the service

XXX = Service operator

Service Relevance to Phuket

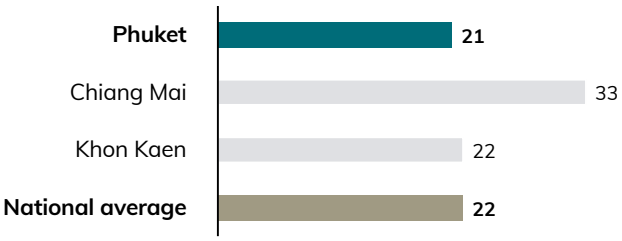
There are three key general drivers to the demand of Telehealth services namely access to healthcare in rural areas, scarcity of healthcare resources and number of public hospitals connected to Telehealth network.

The general understanding of the situation in Phuket is that fullservice hospitals are currently not available in rural areas, with only small clinics present. According to national statistics, 33% of Phuket residents live in rural areas, lower than the national average of 48%. This means that majority of the residents have access to full service hospitals.

Allocation of healthcare resources can also be measured by comparing resources available with population size. A good indicator is the number of hospital beds per population. The lower the number, the more scarce the resource, meaning the more desirable and relevant Telehealth is. Below is a figure comparing the number of hospital beds per 10,000 people in 3 major provinces, Phuket, Chiang Mai and Khon Kaen, as well as the national average. Phuket's number of beds per population is somewhat in line with the national average.

35 telehealth equipment would need to be installed in total.

Number of hospital beds per 10,000 people, 2017 [#]



Source: Ministry of Public Health

The government has plans to launch NHIS (National Health Information System) in Phuket with 4 public hospitals and 21 provincial health promoting hospitals. Currently, it is estimated that there are 10 rural health centers in Phuket. If those were to be connected to the 25 full-service hospitals, then **35 telehealth equipment would need to be installed in total.**

However, considering the fact that almost 70% of Phuket residents have access to full-service hospitals and that the number of beds per 10,000 people are more or less aligned with the national average, the demand for Telehealth is seen to be moderate

Service Readiness

In the context of infrastructure and connectivity, Phuket should be ready for Telehealth, with free Wi-Fi coverage and internet connection across the province. All public hospitals are equipped with internet connection, and even the majority of health centers are in the sub-urban area rather than rural area. Therefore, Phuket has the necessary infrastructure if Telehealth is to be implemented.

In terms of the regulatory landscape, personal liability for potential medical malpractice may act as a barrier for medical personnel to engage in Telehealth. Although Telehealth has not yet been regulated in Thailand, the Thai Medical Council (TMC) has advised members not to provide online counseling for fear that it could be used in lawsuits. However, doctors at public hospitals are protected under the Public Intervening Responsibility Act 1996, which shields these doctors from personal liability. In the event of medical malpractice at public hospitals, the legislation states that the prosecution should file a complaint against the state rather than the doctor. As we foresee Telehealth targeting public hospitals and sub-district health promotion hospitals, personal liability issue should be mitigated in such a setup and therefore not pose as a significant regulatory barrier.

Key Stakeholders

Stakeholders for service set up and/ or operations – For Telehealth in Thailand, responsibilities belong to public agencies who wish to improve healthcare in rural areas. The key stakeholders are mostly ministries related and are those who have initiated the service and provided it. are likely to be large private hospitals, who install, provide and maintain the service.

	Service development	Service operation
Descriptions	> Develop telehealth network, connecting between public hospitals and health clinics > Establish the necessary IT infrastructure across the operating area	> Oversee the regulatory compliance of users as well as ensure the protection of patient's and doctor's rights > Provide doctors resources to help small rural health centers in need of the service
Stakeholders	Ministry of Digital Economy and Society Ministry of Public Health Electronic Government Agency (EGA)	Major public hospitals

Planned & Ongoing Initiatives

Stakeholders for service initiatives – There is no Phuket specific initiatives, however a nationwide initiative currently exists

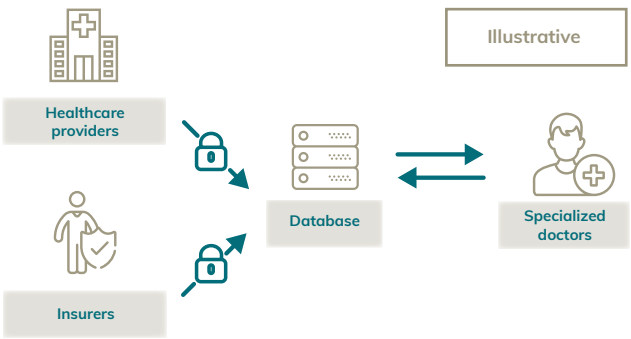
	Initiative description	Coverage/ investment	Benefits	Stakeholders
Initiative 1	> Small health centers under MOPH with connection to specialists from large public hospitals, receiving teleconsultation service > Established in 2009	> MDES has collaborated with MOPH and EGA to develop telehealth system (including network infrastructure and IT system) to link 116 general/ regional hospitals together	> Healthcare consultation service to patients within rural areas, who otherwise would have to travel long distances to large hospitals	**Ministry of Digital Economy (MDES)** **Ministry of Public Health (MOPH)** **Electronic Government Agency (EGA)**

XXX = Public stakeholder

PERSONAL HEALTH RECORD

Service Overview

Function – Personal Health Record (PHR) is an integrated database that stores all information entered by patients to maintain and manage their health information in a private, secure, and confidential environment. It is a lifelong resource of health information used by patients to make health decisions. Individuals own and manage the information in the PHR, which come from healthcare providers, insurers and individuals. PHR is stored in a secure and private platform, whereby the patient will have the right to determine access to the information.



> *"If the government later develops a PHR system linking all hospitals, BDMS can integrate their system to the government's as well. This will not generate direct income, but will help with patient retention and better treatment"*
>
> – Assistant Hospital Director – Bangkok Hospital Phuket

Physically, in the industry, PHR takes the form of a secure webbased tool maintained by an insurer or healthcare provider, depending on whether the country adopts universal healthcare system or not. It can contain both claims and administrative information. PHRs may also include information that is entered by consumers themselves, as well as data from other sources such as pharmacies, labs, and healthcare providers.

Benefit – PHRs enable individual patients and their designated caregivers to view and manage health information and play a greater role in their own healthcare. PHRs also have the potential to help analyze the patient's health profile and identify health threats and improvement opportunities based on analyses of drug interaction, current best medical practices, gaps in current medical care plans and identification of medical errors. Patient illnesses can be tracked in conjunction with healthcare providers, and early interventions can be promoted upon encountering deviation of health status. A long and comprehensive track record can also allow doctors to better diagnose patients providing they have a better understanding of the big picture.

Global Case Studies

Below are the three case studies on Personal Health Record which have been implemented or are being implemented in major cities around the world. Taking these case studies as benchmarks, like many other smart initiatives, a strong collaboration between public sector, who acts as the service provider and operator, and private sector, who acts as technology provider, is common. In addition, implementation usually takes place on a countrywide scale as data need to be comprehensive.

Case Study 1: Denmark

Status & scale:

- Implemented in 2008
- Ongoing with constant upgrades and developments

Service overview

- Consolidate all healthcare data from physicians, hospitals, pharmacies, laboratories and government agencies for patients in a single health portal platform called Sundhed.dk
- Provide ability for patients to access their own health data and past recommendations from health institutions as well as a number of health related encyclopedia

Expected/ realized benefits

- Collective future electronic communication between patients and healthcare providers
- Supporting database for the implementation of the recently launched national digital health strategy, focusing on digitization and utilization of health data in the context of prevention, care and direct treatment

Relevant stakeholders

Ministry of Interior and Health of Denmark (public)– Provides required technology and operates the service

IBM (private) – Provides support, leveraging its WebSphere technology

XXX = Service operator

Case Study 2: Estonia

Status & scale:

- Implemented in 2008
- Ongoing with constant upgrades and developments

Service overview

- Provide nationwide system integrating data from Estonia's various healthcare providers to create a common record that every patient can access online and also allow doctors to access patients' record easily
- Provide e Patient portal where patient can access their data, see who else has accessed it and also close off their data from the system
- Leverage blockchain to ensure security of patient data

Expected/ realized benefits

- Ability to access patient's time critical information such as blood type, allergies recent treatments, ongoing medication or pregnancy during emergency situations
- Better facilitation of the transition to preventive rather than curative medicine, which is more cost-effective

Relevant stakeholders

The Ministry of Health and Labour (public) – Operates the service

Nortal (private) – Develops the solution

Helmes (private) – Develops the solution

XXX = Service operator

Case Study 3: Australia

Status & scale:

- Implemented in 2012
- Service coverage is on a nationwide scale under the initiative called "My Health Record"

Service overview

- Integrate diverse web based Personal Health Record, e.g., prescribed medicines, details of allergies, diagnostic imaging reports, immunization history, wishes about healthcare if the patient becomes too unwell to communicate, pathology reports, hospital discharge information, etc.
- Provide ability for citizens to give permission for health professionals anywhere within the country to access their relevant history and can also ask their doctors not to upload sensitive information such as HIV status, abortion, mental illness or cosmetic surgery

Expected/ realized benefits

- Reduced medication errors and unnecessary duplication of pathology and imaging investigations since as all doctors can access the same information
- Reduced number of avoidable hospital admissions
- Improved coordinated care for those with chronic and complex health conditions
- Easier and safer healthcare management for patients and their doctors, resulting in more life-savings

Relevant stakeholders

Department of Health (public) – Overlooks the service

Digital Health Agency (public) – Provides required technology and operates the service

XXX = Service operator

Service Relevance to Phuket

The adoption of Personal Health Record would be beneficial for any community. The initiative should be adopted nationwide to ensure coherent and comprehensive data collection and storage.

There are a number of reasons why PHR would be beneficial in Phuket. Firstly, the government announced their intention to launch a database of hospitals and improve the quality and continuity of care in the province. After a successful pilot in Nakhon Nayok, Phuket is set to be the next city for the launch.

Secondly, private hospitals in Phuket would benefit by improving database collection and transmission. Currently, many private hospitals in Phuket employ Electronic Medical Record (EMR), however they are only available internally within the hospital. When PHR is implemented, private hospitals would like to merge their current EMR with the public's PHR to create a shared, universal database for better diagnosis and care. Another reason why PHR is suitable for Phuket is due to the fact that the government has aimed to promote the population to be more active in monitoring their own health. PHR will allow the people of Phuket to keep a track record of their own healthcare activity, which would align with the government's agenda.

However, due to Phuket's small size, there are only 3 private hospitals and 15 public hospitals. Combined with the fact that the local population is just below 400,000, investment into PHR may not yield proportional benefit.

There are only

3 private hospitals and

15 public hospitals.

"We have executed many Smart City related projects successfully as we have many capable people and we know when our municipality should outsource for the prompt execution. We will continue using this model to provide Personal Health Record System"

– Deputy Mayor –
Kathu Town Municipality

Service Readiness

Personal Health Record requires little existing infrastructure as hospitals are only required to conduct record keeping electronically which is already the case for all of the hospitals in Phuket. Therefore, there is little concern regarding the infrastructure readiness in Phuket to implement PHR. Within legal aspect, data privacy may act as a barrier to PHRs, as the service involves the collection of sensitive health data. Currently, Thailand does not have a unified and dedicated statute to confer a clear right of data privacy. However, a draft Personal Data Protection Bill is being reviewed by the Council of State. The bill would change personal data privacy requirements in Thailand. Nevertheless, such data privacy concerns could be addressed by hospitals ensuring and communicating to patients that their personal health data would remain confidential and only used by medical personnel during their hospital visits.

Key Stakeholders

Stakeholders for service set up and/ or operations – For Personal Health Record in Thailand, the government is responsible for creating the database and operating it, with the technological knowhow of state/ private entities. Therefore, like many other Smart City initiatives, the public sector would operate the service, and the technology would come from a technology provider, who, in this case, is a state-owned entity.

	Service development	Service operation
Descriptions	> Provide the necessary database and data center to store patient information > Install user interface and integrate with current hospital system > Launch mobile interface to allow patient to view their own record remotely	> Train staff to use the PHR and share the necessary data to create a comprehensive pool of record > Comply with data privacy regulations > Enable doctors to pull out record upon request by the patient > Use database on an anonymous level to conduct analysis and draw useful insights
Stakeholders	National Electronics and Computer Technology Center (NECTEC) Ministry of Public Health	Major public and private hospitals

Planned & Ongoing Initiatives

Stakeholders for service initiatives – There is an ongoing initiative for Personal Health Record in Phuket, in charge by the Ministry of Public Health, with the support of NECTEC and depa. Phuket has been selected as one of the 5 pilot cities for PHRs, which began since 2017.

	Initiative description	Coverage/ investment	Benefits	Stakeholders
Initiative 1	> Basic health information about participating patients is stored in provincial data center, including the integration of information from multiple health institutions together	> 5 pilot provinces (Nakhon Nayok, Phuket, Kanchanaburi, Petchabun, and Roi Et) since 2017	> Increased patients' information sharing between healthcare providers > Access for individuals to their own medical information	**Ministry of Public Health** – Operates the service **depa** – Provides initial support and guidance **NECTEC** – Provides technology XXX = Public stakeholder

REMOTE CLASSROOM/ E-LEARNING PORTAL

Service Overview

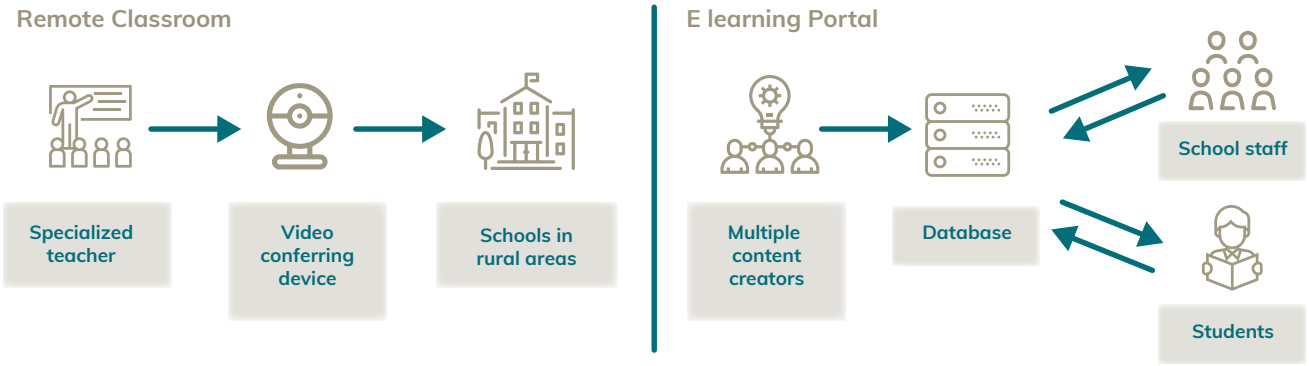
Function – Smart Education is an overarching term for any smart technologies employed in the field of learning and education. As of now, Smart Education initiatives can be categorized into two major types including Remote Classroom and E-learning Portal. Remote Classroom consists of teachers providing classes remotely from one location to students in another location, usually done through a webcam, a monitor with speaker and sometimes even with interactive whiteboard.

Benefit – Remote Classroom is useful in providing high standard education with experienced teachers for small rural schools which may not have specialized teachers for all subjects.

Function – E-learning Portal, on the other hand, is a physical database or cloud system which stores learning materials, recorded classes and other learning resources. This can be accessed through internet for both teachers and students to obtain a shared pool of learning resources. Furthermore, teachers and students can both upload files onto the portal. This could be exercises or even homework submission.

Benefit – E-learning Portal is beneficial as content creators only need to create the content once before sharing with multiple schools. This also saves cost and provides a standardized curriculum for the whole city or nation, regardless of where each school is physically located.

Illustrative



Global Case Studies

Below are the two case studies on Smart Education which has been implemented or are being implemented in major cities around the world. The first one is a case on Remote Classroom and the second one is for E-learning Portal. Taking these case studies as benchmarks, both initiatives are spearheaded by the Ministry of Education, with the help and support of private entities, who provide the technology as well as some funding support.

Case Study 1: Singapore

Status & scale:

- Implemented in 2009
- Service coverage across Singapore under the initiative named “Future School”

Service overview

- Provide a platform for virtual campus where students will be able to collaborate on projects, share information and gather feedback through peer reviews
- Offer students personalized learning with real time diagnostic feedback for assessments and interactive self-paced content

Expected/ realized benefits

- Expected more enriching and engaging learning experience for students
- Open digital textbook framework established for Singapore publishers to share content

Relevant stakeholders

Ministry of Education (public) – Provide overarching vision and necessary support

Civica (private) – Provides required technology and operates the service

Hewlett Packard (private) – Provides required technology and operates the service

Singtel (private) – Provides required technology and operates the service

XXX = Service operator

Case Study 2: Ermelo, South Africa

Status & scale:

- Implemented in 2008
- Service coverage of over 86 schools, over 10,000 students and 190 e-classrooms (as of 2019)

Service overview

- Connect schools all over South Africa to an online learning network under the name of Ligbron E-learning System
- Provide live streaming of mathematics and science lessons which are shared via the use of video conferencing and desktop sharing
- Provide LCD screen with digital camera for each elearning classroom to show the image of the teachers/ learners from linked schools, enabling them to take an active part during lessons
- Provide smart interactive whiteboard board for each elearning classroom to display presentations while students/ teachers can also write on the board and ask questions directly from their own school and they will be displayed and heard by students/ teachers in other schools on the system

Expected/ realized benefits

- **56% increase** in the overall pass rate from participants school after joining the program
- Increased overall grades for students who participate in the program

Relevant stakeholders

Mpumalanga Department of Education (public) – Overlooks service with an aim to improve education standard within the area

Ligbron Academy of Technology (private) – Provides required technology, develops the program and operates the service

XXX = Service operator

Service Relevance to Phuket

To understand the relevance of Smart Education services to Phuket, we propose looking at the three key dimensions. These are access to education, teaching quality disparity and government's willingness to support.

Firstly, access to education is still an issue in Phuket. Approximately 25% of pupils of age between 15 and 17 years old are not receiving any kind of education, whether general nor vocational. This equates to over 20,000 of young people who are not receiving education, partly from difficulty in accessing education and lack of financial means. It is therefore, desirable to provide people living in remote areas with better access to education through smart solutions.

Secondly, Phuket has been facing some of the most apparent teaching quality disparity in the area. Phuket has one of the highest average O-Net (common exam) scores in the country, however, the quality of teachings between schools in the city area and in the rural areas are widely dispersed. Some schools in rural areas have reported shortages of teachers in particular subjects.

This shows that there is a potential for Remote Classroom in Phuket, which would close the gap between the teaching standards within the province.

Finally, the government made it clear that they intend to invest in Phuket's education in order to create a strong foundation for it to become one of the leading Smart Cities in the region. The government has been piloting Q-info, a software that helps track individual student's performance on the computer system.

Looking at the three key dimensions, it is advised that Phuket would greatly benefit from implementing Smart Education initiatives. This is not because the province's education standard is lower than other provinces, far from it, it is because Phuket has set out to become a leading Smart City in SEA, which requires a strong backbone in education to rival other leading cities in the region.

over

20,000

of young people

who are not receiving education, partly from difficulty in accessing education and lack of financial means.

Service Readiness

The key requirement for Phuket to implement Smart Education service is for all the participating schools, especially in the rural areas, to have access to stable internet connection. This is currently not the case for some schools outside the coverage area. However, collaborations with service providers, whether public or private, could easily solve the problem.

Key Stakeholders

Stakeholders for service set up and/ or operations – For Smart Education in Thailand, the government agencies are responsible for leading the initiative to improve education, although many private businesses are now devoting a large proportion of their CSR effort into education. The public sector, however, is still the key stakeholder in charge of allocating budget to different areas and launching policies to promote education such as corporate income tax exemption for education related donations.

	Policymaking and funding	Allocation of budget and support
Descriptions	> Provide the necessary regulatory framework to promote and facilitate the advancement of the Thai education system > Allocate budget regarding education to different areas and different education levels	> Receive budget from the Ministry of Education and allocate to different schools in the province accordingly > Oversee the quality of teaching in the province > Raise and flag any concerns to the related agencies
Stakeholders	Ministry of Education Institute for the Promotion of Teaching Science and Technology	Phuket City Municipality

Planned & Ongoing Initiatives

Stakeholders for service initiatives – There are many ongoing initiatives for Smart Education, however they are usually launched at a nationwide level, not specifically in Phuket. There are many education-related projects which employ technology to enhance teaching. However, not all of them can be categorized as Smart Education. For the purpose of consistency, we have defined Smart Education as those involving remote/ virtual classrooms or interactive database for sharing educational content.

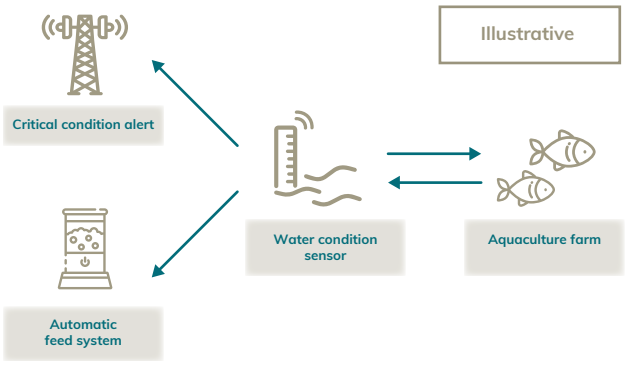
	Initiative description	Coverage/ investment	Benefits	Stakeholders
Initiative 1	> ASEAN Community E-classroom project, an initiative under the ASEAN ICT Master plan 2015, which aims to harness the ICT skills of people with disabilities	> Online course can be accessed remotely from anywhere, and is aimed at people with a wide range of disabilities	> Increased knowledge on ICT skills for everyone regardless of whether they are equipped with disabilities or not	**Ministry of Information and Communications Technology** – Operates the service
Initiative 2	> E-learning materials for the Software Development Degree Program, which is a 100% distance learning program > In addition to translating MIT materials and distributing them online, the Faculty of Engineering develops class materials and provides them free of charge on website	> Accessible from anywhere	> Improved software development knowledge for Thai workforce	**Chulalongkorn University** – Creates content and operates the service

XXX = Public stakeholder

SMART AQUACULTURE

Service Overview

Function – Smart Aquaculture is an overarching term for any smart technologies employed in the aquaculture business. As of today, Smart Aquaculture exists for two main applications. including water condition monitoring and feed management. Water condition monitoring involves the installation of sensors underwater in fish farms to measure the CO2, nitrate, pH, waste levels as well as the temperature. This will allow the fish farmer to be notified if the water condition becomes less than ideal, and can act to troubleshoot the issue promptly.



For automatic feed management, the right amount of feed can be determined by collecting data of any residual feed, and adjusting the feed amount in the next session using artificial intelligence. This can be useful as the number of size of the fish changes over time, the amount of feed required differs. High value aquaculture businesses like lobster or abalone farming present in Phuket, will benefit from smart aquaculture technology, as the stakes are high and marginal losses cannot be tolerated.

Benefit – On a large industrial scale, Smart Aquaculture has been implemented to maximize yield and prevent any loss of value from outbreak of disease or toxic water. It is also often used to predict the water conditions throughout different seasons around the year by collecting historical data. This will allow optimal responses when the scale is large and even marginal losses cannot be tolerated.

As for automatic feed management, the primary benefit is the reduction of human labor and a more precise quantification of the amount of feed required, which can reduce any unnecessary costs, leading to an increase in efficiency.

Global Case Studies

Below are the three case studies on Smart Aquaculture which have been implemented or are being implemented in aquaculture farms around the world. Taking these case studies as benchmarks, it is seen that initiatives are solely developed and operated by private sectors, usually a collaboration between a technology company and fish farms.

Case Study 1: Taiwan

Status & scale:
- Implemented in 2018
- Pilot project coverage of over 13 hectares in area in Southern Taiwan

Service overview
- Monitor data of water conditions via smart phones, leveraging LoRa LPWAN
- Provide smart analysis to better improve aquaculture operations by using big data analytics

Expected/ realized benefits
- Reduced management manpower and power consumption required
- Reduced waterwheel malfunction rate
- Enhanced fish survival rate
- **99.9% accuracy** in data transmission achieved, following months of non-stop trial operation, significantly helping aquaculture operators to reduce unnecessary losses

Relevant stakeholders
Blutech (private)
– Provides required technology

Multiple fish farms (private)
– Operates the service

XXX = Service operator

Case Study 2: Japan

Status & scale:
- Implemented in 2019

Service overview
- Leverage a combination of underwater sensors and data analytics to monitor fish activity in fish farms
- Optimize feeding practices for fish farms, leveraging data analytics and artificial intelligence
- Provide proprietary algorithm that detects when fish are actually hungry, allowing farmers to dispense the right amount of feed at the right time

Expected/ realized benefits
- Reduced operational costs for fish farmers, for whom feeding is more than 70% of their expenditure
- Positive environmental impact achieved, as excess fish feed can create problems like eutrophication, the process by which increased nutrients in water cause imbalance in marine ecosystems

Relevant stakeholders
Umitron (private) – Provides required technology

Multiple fish farms (private)
– Operates the service

XXX = Service operator

Case Study 3: California, USA

Status & scale:
- Implemented in 2014

Service overview
- Provide data tracking as well as video footage
- Provide web-based dashboard that fish farmers can easily access in order to view the collected data
- Offer data analytics and predictive information for fish farmers, as more data are collected

Expected/ realized benefits
- Reduced feed cost due to the monitoring of fish eating habits and changes in feed consumption
- Ability to track fish status or water conditions which can potentially help with disease prevention and control

Relevant stakeholders
Aquaai (private)
– Provides required technology

Kvaroy (private)
– Operates the service

XXX = Service operator

Service Relevance to Phuket

To assess the demand for Smart Aquaculture in Phuket, two major dimensions need to be considered. These include the number of aquaculture farms and their scale as well as the value of aquaculture produce.

Fishery in Phuket are conducted by two main methods, fishing by vessels in deep sea area and fish farms located near the coast. The latter will be the more relevant one regarding the context of Smart Aquaculture in this report. There are a large number of fish farms in Phuket, but most are on a small family-run scale, who would unlikely require the service of Smart Aquaculture. Only large fish and crustacean farms may potentially employ Smart Aquaculture service. By considering this, it can be said that the size of the large-scale fish farming industry in Phuket is quite small.

The second dimension to consider is the value of the aquaculture produce in Phuket. This is important as the number or scale of the fish farms alone may not accurately depict the actual monetary value generated by these businesses. Examples of high value aquaculture produce include lobsters, abalones, shellfish, for which Phuket has an abundant of. Therefore, despite lacking in scale in the first dimension, there may be demand to launch pilots in selected high value aquaculture farms, where marginal losses cannot be tolerated. However, to make the service more sustainable, Smart Aquaculture service may have to be launched on high value aquaculture farms across Phuket and neighboring provinces to achieve a financially viable scale.

Service Readiness

The requirements for Smart Aquaculture to be implemented are reliable source of electricity on-site as well as stable internet connectivity. Electricity is unlikely to be an issue as most large-scale high value aquaculture farms are likely equipped with other instruments already, such as the water filtration and aeration system. Connectivity in terms of Wi-Fi is well established in Phuket, however, these are mostly in the city and unlikely to cover the farm areas. Farm owners may have to install connection equipment, if there is coverage, at their farm.

In the legal or regulatory context, there is currently no barrier that will limit the launch of Smart Aquaculture technologies like water condition monitoring and automatic feed. Therefore, legal and regulatory issues will not be an obstacle to the initiative.

Key Stakeholders

Stakeholders for service set up and/ or operations – For aquaculture in Thailand, the responsibilities belong to the private sector. However, any aquaculture farm extended to the sea may be subject to regulatory framework imposed by the marine department or the municipality.

	Regulations setup	Service development	Operation & maintenance
Descriptions	> Impose regulations to ensure the technology does not effect the pollution level of the area and the surrounding ecology	> Provide the necessary equipment to monitor water conditions and/ or automatic feed system > Conduct analysis and forecast from collected data	> Monitor water conditions on a day-to-day basis > Carry out maintenance
Stakeholders	Phuket City Municipality Marine Office 5, Phuket	Solution provider	• Aquaculture farms • Technology provider

Planned & Ongoing Initiatives

Stakeholders for service initiatives – There are no ongoing smart aquaculture initiatives specific to Phuket at the moment.

SMART TOURISM

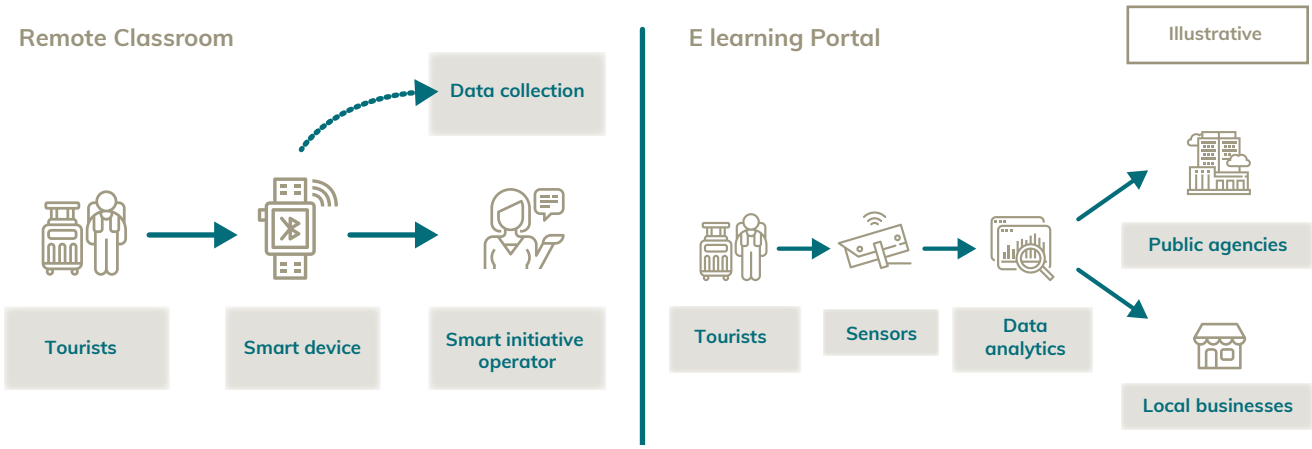
Service Overview

Function – Smart Tourism is an overarching term for any smart technologies employed in the tourism sector. The aim of Smart Tourism is to provide services to tourists in order to make their holiday experience more pleasant and safer, as well as to better understand the behavior of tourists in order to give them the right offerings. Ultimately, it aims to boost the economy of the tourism sector. Therefore, in order to understand how smart technologies can be employed in the tourism sector, it is important to understand both sides of the benefit.

Although there is no, one single smart tourism initiative, the majority of enabling devices take the form of portable gadgets, wearables and mobile application for initiatives aiming to improve tourist experience and data collecting instruments, such as CCTV or sensors for initiatives aiming to collect tourism data.

Benefit – The first type of benefits are those relating to improving the experience of the tourists, and usually covers areas such as navigation, e-payment, language translation, GPS locator, attractions directory. This also includes ensuring their safety, such as emergency contact system and basic health information.

The second type of benefits are those relating to obtaining data regarding tourists' behavior, then analyzing those data, producing insights which will give local businesses and authorities a better understanding on the sector. This will allow local businesses to identify which offerings are in high demand, and for local government to manage traffic in high-congested tourist destinations.



Global Case Studies

Below are the two case studies on Smart Tourism which have been implemented or are being implemented in popular tourist cities around the world. Taking these case studies as benchmarks, it is seen that the initiative is usually implemented under a collaborative effort between the public sector and large technology or telecom companies. The technology or telecom companies would provide the digital solution and the city would operate the technology.

Case Study 1: Helsinki, Finland

Status & scale:
- Implemented in 2019

Service overview
- Provide mobile application that shows the most interesting events, up-to-date information and relevant information for tourists
- Provide ability to fully personalized the content for each user based on preference

Expected/ realized benefits
- Centralized pool of information about local businesses and what to see and do in the city for easier access by tourists
- Enhanced public awareness/ perception of the city as mobile application provides a channel for improved marketing opportunity

Relevant stakeholders

Helsinki Marketing (public) – Launches mobile application and markets the city

Tencent (private) – Provides required technology and develops mobile application

XXX = Service operator

Case Study 2: Antwerp, Belgium

Status & scale:
- Implemented in 2016

Service overview
- Provide real time data stream of the location of all mobile phones connected to its network within the given area, as a result of analyses of the connection of phones to masts across 2G, 3G and 4G networks, as well as use of a timestamp to accurately position a device
- Provide unique anonymous ID to each mobile phone within the given area, displaying via a crowd monitoring tool in order to enhance urban security, improve mobility services and market the city

Expected/ realized benefits
- Ability to display the density of people within small squares across the given area
- Real time crowd monitoring
- Deployment of crowd management solution for local events such as the hosting of the Tour de France and the Tall Ships Races event

Relevant stakeholders

Orange Belgium (private) – Develops network and provides required technology

City of Antwerp (public) – Operates the service, overlooks the city and promotes tourism

XXX = Service operator

> *"Tourists experience in Phuket starts right at the moment when they arrive at the airport, therefore we need to achieve the end-to-end experience enhancement and make them feel as safe as at home throughout their entire time in Phuket"*
>
> – Chief –
> Tourism Authority of
> Thailand (TAT)

Service Relevance to Phuket

There is no doubt that Smart Tourism initiatives would greatly benefit a popular destination like Phuket, the second most visited city in Thailand (excluding Bangkok). As of 2018, Phuket has been receiving an influx of over 14 million visitors, estimated throughout the year of 2018. In November 2018 alone, the number of tourists went over 1 million with an average spend for each visitor at around THB 8,000 per day, generating over THB 40 billion in a single month. Approximately 85% of the value generated came from foreign tourists, who on average spend 50% more per day than their Thai counterparts. There is no question regarding the demand for Smart Tourism in Phuket, the essence is however, how to generate value from this large, and still growing, sector using smart initiatives.

Tourism is the key revenue generating sector for the province and this has been growing steadily over the years. It is desirable to keep this going and the adoption of Smart Tourism initiative could potentially support this by further enhancing visitors' experience, making their stay more convenient and pleasant.

Another interesting insight found is that the average length of stay in Phuket is 4 days (2.7 days for Thais and 4.5 days for foreigners) compared to the national average of 9.5 days. This suggests that there is still opportunity to increase this and further increase the value of the sector. The adoption of Smart City initiative could give businesses and government agencies a better idea as to why this is the current behavior, as well as how best to act in order to change this in a more positive direction.

In November 2018 alone, the number of tourists went over 1 million with an average spend for each visitor at around THB 8,000 per day, generating over

THB 40 billion

in a single month.

Service Readiness

In terms of telecommunication infrastructure, Phuket is equipped with free Wi-Fi hotspots all over the city area. This will allow IoT devices to connect and operate from the existing infrastructure, without the need to set up a new system.

In addition, there may also be an obstacle to Smart Tourism which lies in the area of data privacy. This is because tourist data can only be collected and used for analytics purpose only. However, as long as the service provider seeks users' consent, data privacy is unlikely to pose a significant regulatory issue.

Key Stakeholders

Stakeholders for service set up and/ or operations – For Smart Tourism, the responsibility of boosting the tourism sector belongs to the government, however many private entities are either commissioned or work alongside the government in order for both sides to benefit.

	Tourism sector promotion & boosting	Service development & operation
Descriptions	> Provide direction and select suitable private partners or parties to assist with the initiative > Oversee the regulatory aspects and ensure the protection of tourists' privacy	> Develops smart tourism devices, systems or applications > Establish the necessary IT infrastructure across the operating area
Stakeholders	Ministry of Digital Economy and Society Electronic Government Agency Tourism Authority of Thailand	• Hotel operators • Attractions operators • Travel insurers • Transportation businesses

"New product with new business model is expected to be launched by end of 2019, including the use of facial recognition technology to further strengthen identification process as well as tracking system to improve tourist safety"

– Project Manager – Flowlow

"Most claim incidents involve road accident, drowning and food poisoning; statistically, tourists from China make up the largest portion of the claim"

– Product Manager – Southeast Insurance

Planned & Ongoing Initiatives

Stakeholders for service initiatives – There are many ongoing initiatives for Smart Education, however they are usually launched at a nationwide level, not specifically in Phuket. There are many education-related projects which employ technology to enhance teaching. However, not all of them can be categorized as Smart Education. For the purpose of consistency, we have defined Smart Education as those involving remote/ virtual classrooms or interactive database for sharing educational content.

	Initiative description	Coverage/ investment	Benefits	Stakeholders
Initiative 1	> Out at sea, tourists are provided with smart wristbands, which can track the distance of the tourist from the boat during activities such as diving, alerting operators in real time if tourists go out of range	> Total investment of more than THB 20 million	> Improved safety of individuals participating in marine activities	**Phuket Patri Tour** – Operates the service **depa** – Provides initial support and guidance **CAT** – Provides connectivity
Initiative 2	> Smart wristbands, which store information regarding the user including medical information, in case the user gets caught up in an accident > Also acts as a travel insurance, with maximum claim of THB 1 million over 20 days	> Coverage includes the entire Phuket province > 3 public hospitals are collaborating to assist during emergency situations > Phuket Provincial Police are also involves in case of tracking or locating of tourists	> Improved safety of individuals participating in marine activities > Provision of affordable insurance > E-payment via QR code	**Flowlow** – Develops and operates the service **Tourism Authority of Thailand** – Provides support **Southeast Insurance** – Provides travel insurance

XXX = Public stakeholder

CHAPTER

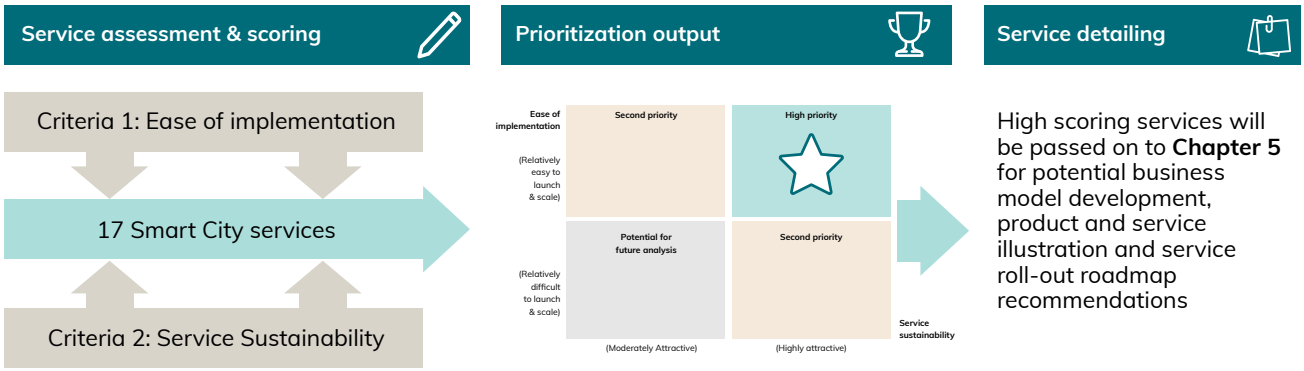
04

PRIORITIZATION OF SMART CITY SERVICES FOR PHUKET

SMART CITY SERVICES PRIORITIZATION

In this section, we will shortlist our long list Smart City services for business model development, partnership identification and service feature detailing in Chapter 3. This section will provide the detailed explanation of the methodology introduction, services prioritization, and prioritization output.

Methodology introduction



In service assessment and scoring, we have formulated two criteria to identify high priority services to progress to Chapter 5 for business model development. These two criteria are developed to ensure that they are beneficial and scalable and that they can be proven case studies for scaling at national level.

The first assessment criteria is Ease of Implementation which assesses the launch potential of the service at provincial level. This criteria consists of two sub-criteria that cover both service readiness and existing initiative.

- Service readiness (80%) – To assess the readiness of existing infrastructure and regulations that can potentially limit/ foster the development of Smart City services in Phuket
- Existing initiative (20%) – To understand if there are any ongoing initiatives that currently provide tangible benefits to Phuket, since previously launched Proof of Concept (POC) can potentially ease the launch of Smart City services

Service readiness is given a very high weighting of 80% as successful launch of Smart City services will heavily depend and rely on how well-established existing infrastructure within the province is. Hence, the higher standard and quality of the supporting infrastructure is, the easier the launch would be as the process will be treated merely as the upgrade of existing infrastructure rather than starting from scratch.

Existing initiative is another supporting factor that cannot be ignored and can further facilitate the implementation if studied well prior to the service launch. Therefore, a smaller weighting of 20% is given as analyzing ongoing initiatives would be beneficial in identifying key learnings from previously-launched initiatives, although this is relatively less important than service readiness.

The second assessment criteria is Service Sustainability which assesses if the service is commercially viable as well as how relevant it is to Phuket.

- Demand (60%) – To understand if each Smart City service has potential to address as-is issues and/ or enhance service offerings of existing services in Phuket. This sub-criteria can be assessed based on 1) The relevance of service to existing issues or problems in Phuket and 2) The needs of current service offering enhancement.

- Business feasibility (40%) – To assess whether the service provides any financial benefits to the service operator as well as if any additional revenue stream could be potentially created upon the service expansion. This sub-criteria will be graded mostly using 1) The identification of revenue and/or cost saving source specifically for the launch in Phuket and 2) Qualitative justification on whether there are any possible channels for generating additional income, once the service has been scaled, other than through the service's main income source (NOTE: We will not go into the specific quantitative aspects such as profit, as that would be difficult to quantify accurately).

Demand is given the weighting of 60% as it governs how relevant the service is to Phuket and is also the main driving factor for service prioritization. By assessing both the service's potential to solve existing issues and the need to enhance current offerings, the degree of sustainability of the service could be identified.

Business feasibility, instead, contributes a slightly less weighting of 40% towards the identification of Service Sustainability. Financial benefits though are key to sustaining service operations, should not be the first priority when assessing for its sustainability, since high enough demand alone will be able to prolong the service operations in the beginning, while high financial impact will be beneficial for sustaining the service in the long run.

These two criteria will be assessed for all 17 Smart City services and will be mapped onto our 2-by-2 prioritization matrix to identify high priority services for detailed development in Chapter 5.

Services that receive high score for Ease of Implementation and Service Sustainability will be passed on to Chapter 5 as we want to ensure that they are quick-win services to support dry run and provide benefits to the locals. However, other services in other quadrants will not be eliminated but instead will be kept for future analyses or as second development priority.

For the high priority services (high score on both criteria), detailed business model, service and product features and service roll-out roadmap recommendation will be develop later in Chapter 5.

Evaluation Scoring

As elaborated in the previous section, the assessment focuses on 2 main criteria, Ease of Implementation and Feasibility; the 2 can be broken down further into 4 sub-criteria including services readiness, existing initiative, demand and business feasibility respectively. These criteria are given a rating ranging from high, mid to limited, according to the systematic guideline summarized in the figure below.

Service readiness

Limited service readiness implies there is either no or extremely limited (e.g. covers 1 district only) infrastructure built to support a particular service, or there is a strong regulatory barrier against the service. If an initiative satisfies any of the 2 conditions above, it will be graded as limited in terms of service readiness.

Moving up the scale, "Mid" service readiness would mean there is supporting infrastructure only in the urban area (not rural) with room to improve. This is often the case for many smart initiatives in Thailand where the focus is on densely populated in urban area. If an initiative satisfies this condition or has no supporting regulations, it will be graded as "Mid" service readiness.

Finally, for "High" service readiness, an initiative has to have strong supporting infrastructure across both urban and non-urban areas, or has strong supporting regulations from the government.

Existing initiative

Limited existing initiative simply means there is currently no particular Smart City initiative, either completed or on-going, in Thailand. "Mid" is defined as having that particular Smart City initiative completed or on-ongoing in Thailand, but not in Phuket specifically. "High" existing initiative means the particular Smart City initiative has been launched or is on-going specifically in Phuket.

Demand

Limited demand implies that the Smart City initiative does not tackle Phuket's major problems nor does it help enhance Phuket's strength such as tourism or the economy in general. "Mid" demand is when an initiative is related to tackling problems in Phuket and improving the local economy, but may not be in the areas which are of urgent priority for Phuket. Finally, "High" demand denotes any initiative that corresponds to tackling Phuket's high priority problems or has the potential to enhance Phuket's focused sector (i.e. tourism).

Business feasibility

Limited business feasibility describes a Smart City initiative which is unlikely to provide any financial benefit (i.e. income) to the service provider, nor does it provide any cost saving benefits. Many of the services which do not generate income or cost savings are likely those which are deployed to benefit and support the community or the city as a whole, giving non-monetary benefits rather than business-related ones.

"Mid" business feasibility is when the Smart City initiative is able to generate income for the service provider, however, this may not be significant compare to the scale of the project nor does it possess the scalability which would make it a highly attractive business.

Finally, a "High" business feasibility rating is given to Smart City initiatives which are likely to generate significant income to the service operator, and in addition, has the potential to secure additional income sources in related services or fields.

Each of the 17 Smart City services shortlisted will be given a high, mid or limited rating for each of the category (service readiness, existing initiative, demand and business feasibility). High will be allocated 3 points, mid will be allocated 2 points and limited will be allocated 1 point. The total points for each initiative will be used to do the final shortlist for the prioritized services specific to Phuket.

	Criteria 1 (Ease of implementation)		Criteria 2 (Feasibility)	
	Service readiness	**Existing initiative**	**Demand**	**Business feasibility**
High	> Available across both urban and non-urban areas with limited needs of enhancing OR has strong supporting regulations	> On-going SC initiative available in Phuket OR beyond	> Highly relevant to Phuket's problems > Strong potential to improve Phuket's capabilities	> Has significant financial benefit to service operator with potential for additional income sources
Mid	> Infrastructure available in urban areas with room to enhance coverage OR has no supporting regulations	> On-going SC initiative available in other provinces (excluding Phuket)	> Somewhat relevant to Phuket's problems > Moderately important to Phuket's economy	> Has financial benefit to service operator
Limited	> No infrastructure available or only in limited area (i.e. one district area) OR high regulation barrier	> No on-going SC initiatives available in Thailand	> Limited problems in Phuket as compared to other provinces > Not important to local and tourists' needs for enhancing Phuket's economy, etc.	> No financial benefit to the service operator (from both top line and cost saving aspects)

Service assessment & scoring

Below is the service assessment & scoring across 17 Smart City services. Each service will be scored High, Medium and Limited across all sub criteria. Each sub criteria will have different weighting as they are not equally important for the dry run and development of Smart City services in Phuket.

	Ease of implementation		Service sustainability		Priority (Score)
Smart City service	Service readiness (80%)	Existing initiative (20%)	Demand (60%)	Business feasibility (40%)	
Smart Electric Metering	●	●	●	●	High (5.2)
Smart Water Metering	●	●	●	●	Second (4.6)
Smart Lighting	●	●	●	●	Second (4.8)
Smart Parking	●	●	●	●	Second (4.6)
Smart Traffic Light	●	●	●	●	High (5.6)
Smart Public Transport	●	●	●	●	High (5.2)
Vessel Tracking & Monitoring	●	●	●	●	Second (4.8)
Smart Waste Management	●	●	●	●	High (5.2)
Smart Air Quality Monitoring	●	●	●	●	For future analysis (4.0)
Integrated CCTV system	●	●	●	●	High (5.6)
Smart Disaster Warning & Alert	●	●	●	●	Second (4.6)
Remote Patient Monitoring	●	●	●	●	For future analysis (3.8)
Telehealth	●	●	●	●	For future analysis (3.0)

Smart City service	Ease of implementation: Service readiness (80%)	Ease of implementation: Existing initiative (20%)	Service sustainability: Demand (60%)	Service sustainability: Business feasibility (40%)	Priority (Score)
Personal Health Records	●	●	●	●	Second (4.6)
Remote Classroom/ E-learning Portal	●	●	●	●	Second (4.6)
Smart Aquaculture	●	●	●	●	For future analysis (4.0)
Smart Tourism	●	●	●	●	High (6.0)

● High scoring ● Moderate scoring ● Limited scoring High service priority scoring

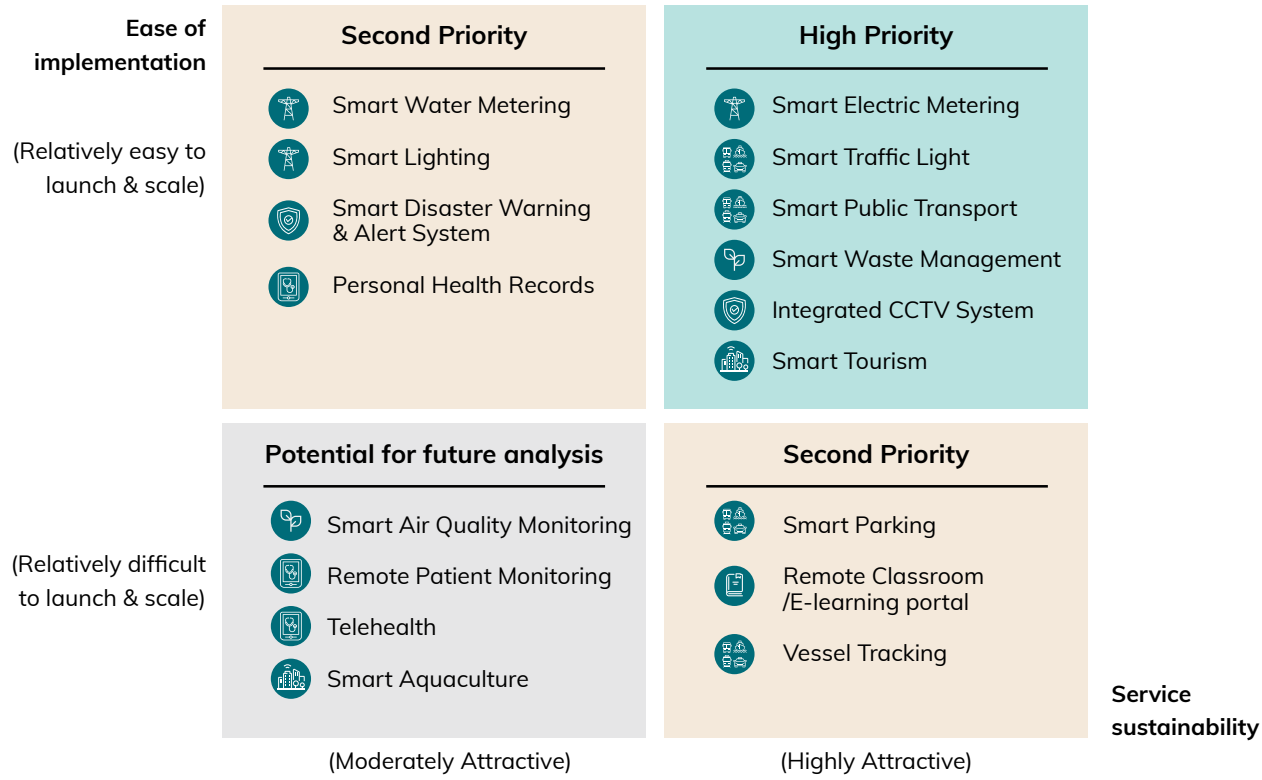
Smart City service	Ease of implementation: Service readiness (80%)	Ease of implementation: Existing initiative (20%)	Service sustainability: Demand (60%)	Service sustainability: Business feasibility (40%)
Smart Electric Metering	**High** – Every household in Phuket has access to electricity with metering system, with citywide network of Wi-Fi points to support full function of the service; No regulation/ barrier limiting the launch	**Limited** – There is no ongoing initiative with tangible benefits available in Phuket and at national level	**High** – Service is highly relevant as Phuket has high electricity consumption per capita with stronger growth rate compared to other provinces in the region and national level	**Mid** – The service operator can experience cost saving from remote metering record from the operations center without deploying metermen
Smart Water Metering	**High** – Majority of households have access to smart phone & sanitized water source with metering system to support full function of the service; no regulation limits the service launch	**Limited** – There is no ongoing initiative with tangible benefits available in Phuket and at national level	**Mid** – The service is somewhat relevant to Phuket as the service can provide moderate consumption saving to households and leakage identification to the waterworks authority	**Mid** – The service operator can experience cost saving from remote metering record from the operations center without deploying metermen
Smart Lighting	**High** – Phuket has wide coverage of existing lamp posts; LPWAN connectivity available at provincial wide to support the service launch; No regulation limits the service launch	**Mid** – There is an ongoing initiative available in Chiang Mai with some early stage initiatives across other provinces	**Mid** – The solution can potentially address high operations and maintenance costs of traditional light bulbs and enhance bright areas to increase safety across the province	**Mid** – The cost saving can be offered by the solution from energy supply optimization and predictive maintenance/ replacement features
Smart Parking	**Mid** – Sensors can be installed in some of the dedicated parking areas (excluding on-street parking without designated boundary) across Phuket, with citywide Wi-Fi points; no regulation/ barrier limiting the launch of the service, however approvals from building owners and/ or municipalities are required for sensors installation	**Mid** – There are ongoing initiatives available in Bangkok and Khon Kaen	**High** – Service is highly relevant as Phuket has higher number of vehicle per capita when compared to other major provinces and national average, as well as increasing local complaints on traffic congestion issue	**Mid** – Service only provides financial benefit to service operator in case of off-street parking as on-street parking is currently not charged
Smart Traffic Light	**High** – Vehicle detection sensors need to be installed on the road or attached to existing traffic light system with citywide network of Wi-Fi points to support full function of the service; No regulation/ barrier limiting the launch of the service	**High** – There is ongoing initiative with tangible benefits available in Phuket	**High** – Service is highly relevant as Phuket has higher number of vehicle per capita when compared to other major provinces and national average, as well as higher proportion of road accidents caused by speeding violation	**Mid** – Service operator receives financial benefit as service automatically triggers fines for drivers with traffic violations

	Ease of implementation		Service sustainability	
Smart City service	Service readiness (80%)	Existing initiative (20%)	Demand (60%)	Business feasibility (40%)
Smart Public Transport	**High** – Phuket has citywide network of Wi-Fi points to support the launch of the service via mobile application platform; there is regulation barrier on data privacy to be considered before launching the service	**High** – There are ongoing initiatives with tangible benefits available in Phuket and Bangkok	**High** – Service is highly relevant as Phuket has higher number of vehicle per capita when compared to other major provinces and national average, as well as there is limited amount of real time information on public transport routes and schedule available	**Limited** – Service has no financial benefit to service operator
Vessel Tracking & Monitoring system	**Mid** – Mobile in-vessel devices can be easily installed on vessels, with citywide Wi-Fi points; existing requirement from Marine Department for all vessels to be equipped with tracking devices to support the launch, otherwise no other limiting regulation	**High** – There are ongoing initiatives with tangible benefits available in Phuket as well as other provinces with connection to the sea	**High** – Service is highly relevant as Phuket is the province with third highest number of visitors in Thailand and fourth highest number of fishing vessels among provinces on the Andaman coast	**Mid** – Service only provides financial benefit to service operator in case of recreational ferries tracking as it facilitates visitors when using ferry service, however there is no financial benefit in case of fishing vessels tracking
Smart Waste Management	**Mid** – Phuket only has designated waste collection points in urban area to support the sensor and service installation; No regulation barrier, only permission required prior to trash bin modification	**High** – Proven concept available in Phuket with tangible benefits providing to Patong district in Phuket	**High** – The service has strong potential to address uncollected waste issue and large volume of generated waste per capita from locals and tourists in Phuket	**High** – The service can provide cost saving and higher operational efficiency to the operator from better route and schedule pick up optimization
Smart Air Quality Monitoring	**High** – No existing infrastructure is required for smart air quality. Sensors need to be installed and readings sent over the internet to a command center; There are no regulations to forbid air monitoring in Phuket	**High** – There are ongoing initiatives available in Bangkok and Khon Kaen	**Limited** – Service is highly relevant as Phuket has higher number of vehicle per capita when compared to other major provinces and national average, as well as increasing local complaints on traffic congestion issue	**Limited** – Service only provides financial benefit to service operator in case of off-street parking as on-street parking is currently not charged
Integrated CCTV system	**High** – Phuket has wide coverage of installed CCTVs across the province with rooms to upgrade to real-time and integrated CCTV; No regulation barrier, but the operator to keep data privacy related regulations in mind	**High** – On-going initiative available in Phuket with supports from both private and public agencies	**High** – The service is highly relevant to Phuket as it can help monitor large number of locals and tourist and increase as-is area coverage of current number CCTVs in Phuket	**Mid** – The operator can potentially experience cost saving from realtime video file retrieving from the operation centers as all CCTVs are connected and linked to the command center
Smart Disaster Warning & Alert	**High** – Sensors can be easily installed in strategically important areas across Phuket, with citywide Wi-Fi points to support full function of the service; No regulation limiting the launch but approvals from related agencies are required for sensors installation	**High** – There is ongoing initiative with tangible benefits available in Phuket	**Mid** – Service is required in specific coastal areas and tectonic boundaries to indicate risk for flooding and earthquake/ Tsunami respectively the command center	**Limited** – Service has no financial benefit to service operator

Smart City service	Ease of implementation		Service sustainability	
	Service readiness (80%)	Existing initiative (20%)	Demand (60%)	Business feasibility (40%)
Remote Patient Monitoring	Mid – Internet connection is required at both the healthcare provider's location and the patient's location (if not yet established); No direct legal barrier, however, the Liability and Data privacy Act can come to play if serious malfunction occurs	Mid – There has been ad-hoc initiatives and pilots launched by BDMS in Thailand, however, no Phuket specific project has been announced	Limited – Phuket has an average proportion of elderly population but low proportion of diabetic patients; this means the demand is limited and usually exclusive to private hospital customers only	High – The service operator is likely to be private hospital groups, who could generate significant income from the monitoring service; as well as other addition care services due to frequent and close interaction with their customers
Telehealth	Mid – Internet connection is required at both the healthcare provider's location and the patient's location (if not yet established); No direct legal barrier, however, the Thai Medical Council advises against Telehealth due to concern of lawsuits	Mid – There are no ongoing initiatives in Phuket, however, MDES has collaborated with MOPH and EGA to develop telehealth system, which is being piloted around the country	Limited – 33% of Phuket's residents live in rural areas, lower than the national average of 48%. Combined with Phuket's relatively small size, majority of the population live within a close proximity of public hospitals	Limited – The service operator, who will be providing the platform for doctors in to counsel patients remotely, is unlikely to be able to generate income from the service; The exception is if the service is provided by private hospitals to their patients
Personal Health Record	High – Personal Health Record requires little existing infrastructure, hospitals are only required to conduct record keeping electronically. No regulatory barrier will inhibit PHR as long as consent is given by the patient	High – There is an ongoing initiative for Personal Health Records in Phuket, in charge by the Ministry of Public Health, with the support of NECTEC and depa since 2017	Mid – The population of Phuket would benefit from a holistic and comprehensive record keeping of their healthcare information, however, due to relatively small population, limited scalability could be an issue	Limited – The service operator, who provides the database and platform, is unlikely to generate income, unless they charge hospitals, which is unlikely
Remote Classroom/ E-learning portal	Mid – All participating schools, especially in the rural areas, must have access to stable internet connection, which is currently not the case. However, there is a strong push from the government, for example CIT exemption for any related CSR activity	Mid – There many ongoing initiatives for Smart Education, however they are usually launched nationwide, not specifically in Phuket	High – Phuket has set out to become a leading Smart City in SEA, which requires a strong backbone in education to rival other leading cities in the region	Mid – Service operator may be able to charge schools in exchange for content and teaching resources. However, this would defeat the purpose of attempting to close the gap between rural and urban schools, as only private schools would be able to pay for the service
Smart Aquaculture	High – The requirements for smart aquaculture to be implemented are a reliable source of electricity on-site and stable internet connectivity. There are currently no legal barrier against smart aquaculture	Limited – There are currently no smart aquaculture initiatives in Thailand	Limited – Most aquaculture farms in Phuket are small-scale family run businesses who are unlikely to adopt smart aquaculture. Only high-value farms may benefit, however there is lack of scale in Phuket	Mid – Service operator is guaranteed to generate income when providing the service form aquaculture farm owners. However, revenue stream is mainly limited to monitoring and automatic feed due to technological limit
Smart Tourism	High – Phuket is equipped with free Wi-Fi hotspots all over the city area; this will allow IoT devices to connect and operate from the existing infrastructure. The Data Privacy Act will not be an issue as long as consent is provided by users of the service	High – There are multiple smart tourism initiatives in Phuket, most of which are in the form of smart wristbands, using technologies such as GPS, QR code and Epayment to ensure the users' safety as well as convenience	High – Phuket is the 3rd most visited city in Thailand. As of 2018, Phuket has been receiving an influx of over 9 million tourists, estimated throughout the year of 2018; tourism is the main source of income for the province. There is still room to grow, for instance increasing stay duration and average spending per day for tourists	High – Although income depends on the service being provided, many existing service providers have secured stable and significant revenue streams, which continues to branch out into many other related services (e.g. insurance, e-payment)

Prioritization output

We have mapped 17 Smart City services onto 2-by-2 prioritization matrix below based on their scoring of two criteria. High attractive and relatively easy to launch & scale services will be passed on chapter 5 for detail business model development, stakeholder identification, etc.



High Priority Initiatives - Top right quadrant

The services which fall into this quadrant are the ones we believe will be feasible and sustainable in the long run and has high potential for successful implementation. These are initiatives which have scored 5.0 or above. The prioritized services for Phuket include: Smart Electric Metering, Smart Traffic Light, Smart Public Transport, Smart Waste Management, Integrated CCTV System and Smart Tourism. Smart Electric Metering is in the high priority quadrant due to Phuket's readiness in infrastructure and high demand; with households being equipped with metering system and internet connection as well as having relatively greater need to better manage electricity usage. Smart Traffic Light is highly prioritized due to the readiness of existing infrastructure and high number of traffic congestion issues faced in urban areas of Phuket. Smart Public Transport is also highly relevant due to heavy traffic congestion caused by the high dependency on private vehicles as well as limited availability of real time information regarding public transport routes and schedule. Smart Waste Management also falls into the high priority quadrant due to extremely high demand with influx of tourists, as well as already having on-going initiatives in some areas of the province. Integrated CCTV is selected for similar reasons, having the required infrastructure, high demand as well as on-going initiatives in Phuket already. Finally, Smart Tourism is seen as highly attractive as well as having the required regulatory and public infrastructure support; it is likely to help boost Phuket's economy as well as generate substantial and sustainable income for the service operator.

Second Priority Initiatives – Top left and bottom right quadrants

This level can be split into 2 types, the top left quadrant is the "second priority" due to high service sustainability but relatively difficult to launch & scale. The services within this territory are those that we consider easy to implement in Phuket, but with limited or less attractive outlook on service sustainability (i.e. may not be successful in the long run); these are the initiatives scoring between 4.4 and 5.0 with a higher ease of implementation score than service sustainability score. The bottom right quadrant is designated as "second priority" due to high service sustainability, but relatively difficult to launch & scale. The services here are those that have high potential in terms of sustainability and feasibility to be successful in the long-run, but may be more challenging to implement in Phuket due to their nature; these are the initiatives scoring between 4.4 and 5.0 with a higher ease of service sustainability score than implementation score.

Potential for Future Analysis – Bottom left quadrant

These services are those we believe are still difficult to implement in Phuket, and may have less potential in becoming sustainable in the long-run. However, with everchanging regulatory landscape and rapid development of public infrastructure in Phuket, it would be wiser not to rule them out, as all of them have the potential to benefit Phuket in some shapes or forms.

Rationale for selecting each prioritized initiatives

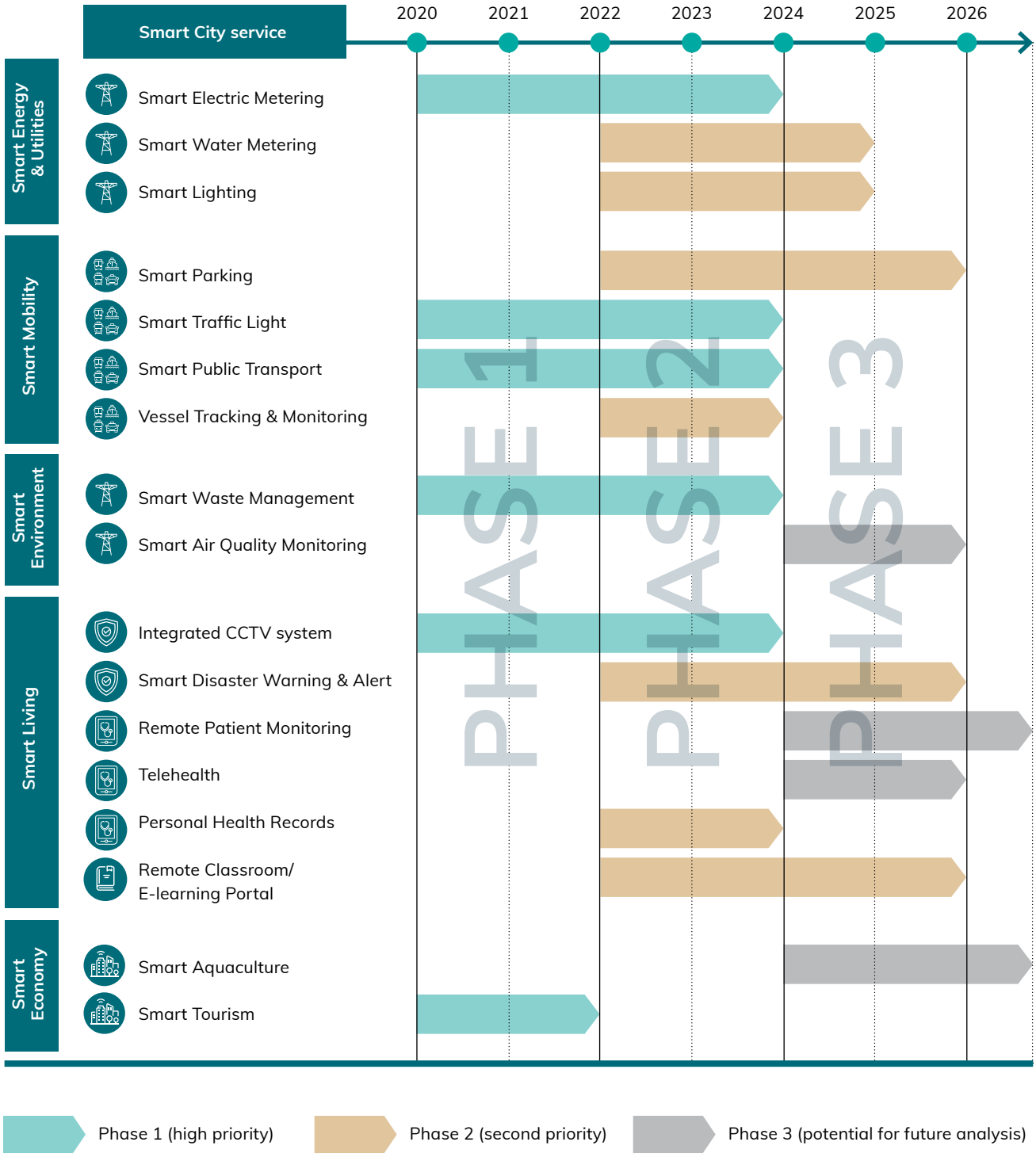
Through our prioritization matrix, 6 initiatives were selected on the merit of their score; satisfying the four criteria we have set. However, it is also important to take into account opinions and suggestions of the local stakeholders into selecting the initiatives to implement, as that would yield the most practical outcome. For this reason, this section will set out to elaborate what the local stakeholders think about the prioritized initiatives and how the initiatives will help to solve Phuket's problems.

Prioritized Initiatives	Opinions of local stakeholders
Smart Electric Metering > Smart Electric Metering will have two-fold benefit for Phuket. Civilians and businesses will be able to monitor and control their electricity usage, whereas the electricity authority will be able to achieve a wholistic view of energy usage over the whole province > With regular power cuts, authorities would greatly benefit from being able to monitor usage level in order to be alerted before a blackout occurs and respond appropriately > Large business chains or associations (eg. Phuket hotel association) will be an attractive group to begin piloting as the stakes are high and blackouts cannot be tolerated	*"Phuket often experiences blackouts due to unforeseen surge in power usage, authorities should have the capability to monitor [electricity usage] so that they can prevent it"* - Federation of Phuket Industries
Smart Traffic Light > Heavy traffic is one of the key urban issues in Phuket, especially during peak hours in the city > Smart Traffic Light will allow a more synchronized traffic light management, allowing for better flow of cars to ease congestion > Furthermore, sensors employed will detect car density on each roads and correctly issue "green lights" on congested routes, rather than empty ones	*"Traffic is extremely bad during peak hours and when there is construction; appropriate traffic management should be put in place to prevent this"* - Resident in Phuket
Smart Public Transport > Public transport in Phuket is limited, and even more so for non-Thai visitors due to language barrier and confusion with pick-up/ drop-off points > Due to high transportation cost, there is a need for locals and visitors to plan their routes efficiently, in order not to incur unnecessary costs > Smart Public Transport will provide a platform for both locals and tourists to plan their routes as well as know the exact time which their chosen transportation mode will arrive > Smart Public Transport will also provide a platform which is understood by foreigners, via multiple language options, to make their journeys more convenient	*"It is very inconvenient for me to approach and ask locals about bus/Songthaew routes, since there's hardly any information available online in English; I have no idea when buses would arrive or where to get on"* - Tourist in Phuket
Smart Waste Management > Phuket has a larger volume of annual generated waste per capita, owing to large number of visitors and people from neighboring areas who migrated to work in the city > However, resource from the central government is allocated in proportion to registered residents, who make up only a small portion of the actual population > Therefore, it is crucial to utilize the allocated resource as efficiently as possible using Smart Waste Management, eliminating unnecessary rubbish collection and instead relying on on-demand collection	*"Trash bins in congested areas will overflow without efficient waste management system; budget allocated is tight to take care of the growing amount of waste"* - D'Kids, smart waste initiative operator

Prioritized Initiatives	Opinions of local stakeholders
Integrated CCTV > Although not notorious, thefts and petty crimes has been reported in Phuket, which concerns locals and visitors alike > Many of the CCTVs in Phuket are operated by different parties with no compatibility for viewing on one single platform > Integrated CCTV will offer a platform which links all of the CCTVs together, allowing for better surveillance and detection of crime, ultimately leading to a safer destination for visitors and locals	*"CCTVs are not yet fully integrated and we need a central entity to drive CCTV integration across Phuket as well as provide both service operations and maintenance"* - Department of Disaster Prevention and Mitigation
Smart Tourism > Tourism is one of the major economic drivers for Phuket, however the province still lacks a collective data platform mainly due to the fact that sharing of tourism-related data among relevant entities are still very limited > Many tourists reported that their main issue with Phuket is that there is no one single platform where they can get access to all of the services required to make their journey smoother (eg. ride hailing, help point locating, events update) > Smart Tourism will consist of multiple initiatives to satisfy both tourists, who wants convenience & peace of mine, and authorities, who would benefit from understanding more about tourists' behaviors and their needs	*"We need to remain competitive against other tourist destinations nearby; understanding the needs of tourists and providing a smooth worry-free holiday for them is key"* -Renaissance Hotel Phuket

Initiative Roadmap

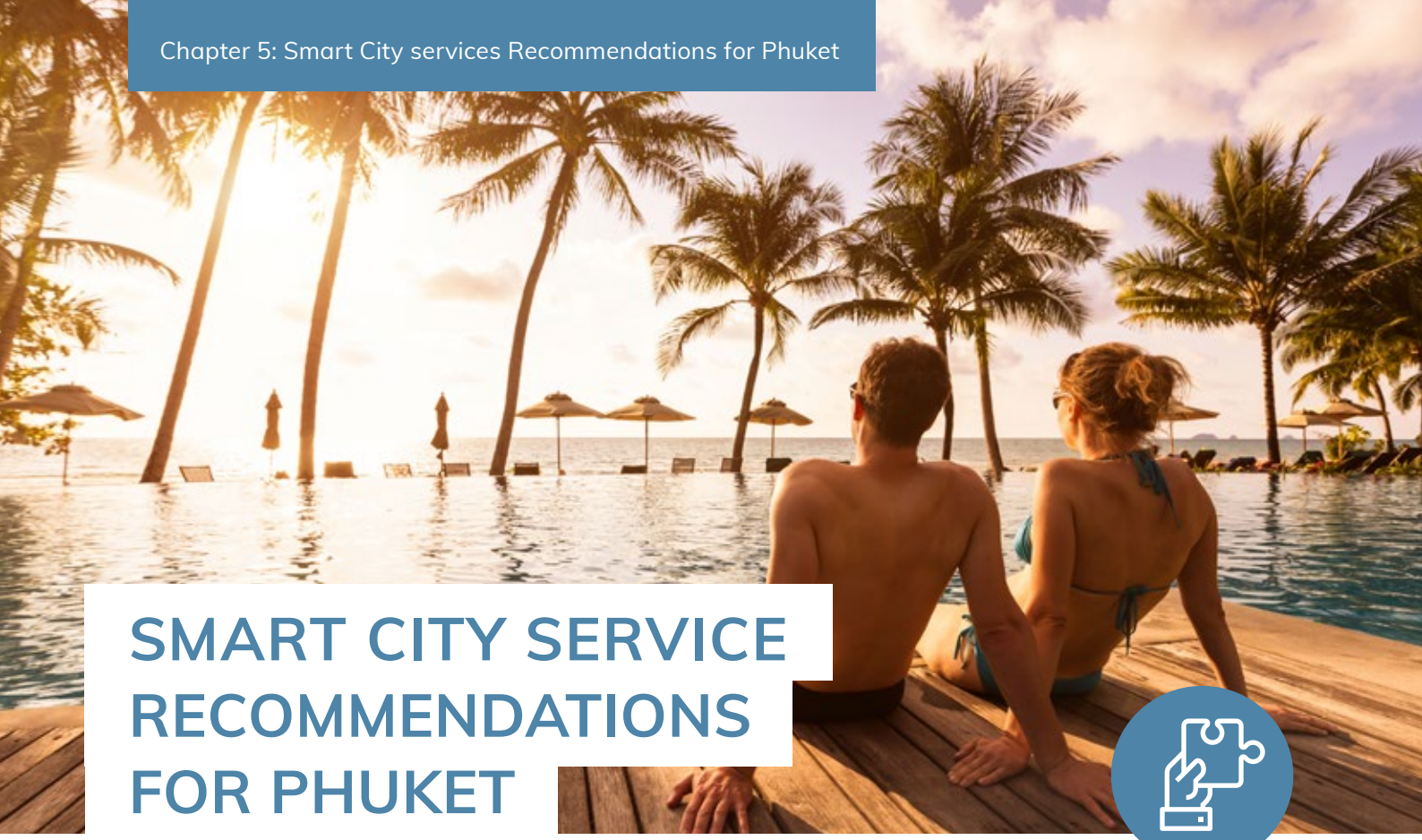
We propose launching the initiatives in 3 phases; 1st phase in 2020 would be for the high priority initiatives; 2nd phase in 2022 would be the second priority initiatives; and 3rd phase in 2024 would be the "potential for future analysis" initiatives, if further study suggests they should be implemented. The estimated implementation time periods are taken from international best practice and RB Smart City Index.



CHAPTER

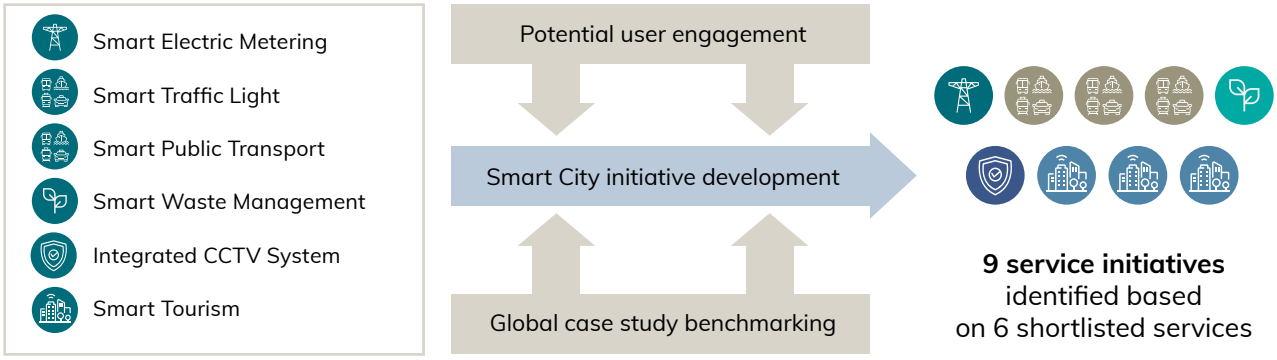
05

SMART CITY SERVICES RECOMMENDATIONS FOR PHUKET



SMART CITY SERVICE RECOMMENDATIONS FOR PHUKET

In this chapter, we will develop service initiatives of 6 shortlisted services from Chapter 4. For all service initiatives, we will provide initiative overview, potential issues to be addressed in Phuket, service operator role assessment, business model and action plan. Below is the methodology for service initiative development.



In order to identify service initiatives that will be practical in the sense that they have high potential to fully address key existing issues in Phuket as well as appreciated by locals, we have engaged with a number of entities who are considered to be potential service operators and service users across the province in order to ensure that we deeply understand their requirement and needs. Benchmarking with worldwide best-practice cases have also been conducted along the process to supplement key insights obtained from numerous engagement with the locals as well as to align our findings with successful use cases in order to ensure high service feasibility upon launching. With insights gathered through both primary and secondary research, we are able to formulate 8 high potential service initiatives that will be able to improve competitiveness of Phuket as a whole.

Shortlisted services	Service initiative	Initiative overview	Relevance to Phuket	Potential operators
Smart Electric Metering	**Electricity meters with advanced analytics for consumption monitoring purpose**	Implementation of electronic meters equipped with advanced analytics to monitor and record real time electricity consumptions so that customers can better control their electricity expense	Phuket has a rapid increase in electricity consumption with growth rate higher than those of national average as well as of Southern region, along with the fourth highest number of electricity customers within the region	> Provincial Electricity Authority (PEA)
Smart Traffic Light	**Sensors with special algorithms / AI for traffic flow optimization purpose**	Installation of vehicle detection sensors in areas with traffic light system to obtain real time traffic flow information, which will be further processed by the central control system so that traffic lights' duration and frequency could be optimized accordingly	Heavy traffic congestion is one of the key urban issues in Phuket due to the increase in vehicle ownership, causing the number of registered vehicle per capita in Phuket to be twice higher than the figure for national average	> Phuket Provincial Police
	Cameras for monitoring of traffic law violations by drivers and motorists	Installation of cameras attached on traffic light system that can monitor vehicles' speed as well as identify license plates of vehicles violating traffic laws, so that fines could be automatically triggered from the control center directly to their owners	Phuket has an increasing number of traffic law violations, especially speeding which has accounted for approximately one third of the total annual road accidents, as a result of high number of vehicles on the road	> Phuket Provincial Police
Smart Public Transport	**Collective digital platform with multi-modal mobility solutions for public transport**	Centralized platform for commuters with a wide range of public transport modes that facilitates end-to-end process of public transport usage around the province so that commuters can plan, book and pay for their trips in single platform	Traffic congestion is the main problem in Phuket due to higher vehicles per capita than national average while online real time information for public transport is also limited, leading to the need for solution that encourages more public transport usage	> Phuket Land Transport Office > Appointed private company
Smart Waste Management	**Waste collection sensors with integrated route planning system**	Installation of sensors on trash bins to measure and track waste level, with alerts to the operation center when their capacities are nearly full, as well as with route planning optimization for rubbish trucks during waste collection process	Phuket has a larger volume of annual generated waste per capita when compared to the national average as well as limited supporting infrastructure, resulting in large volume of uncollected and untreated waste	> Municipalities > Appointed private company
Integrated CCTV System	**Fully integrated CCTVs with facial recognition ability for public safety enhancement**	Integration of all CCTVs along with integrated solutions such as facial and behavior recognition to a single command center to collect real time information and provide instant alerts	Phuket has a higher number of population per one police officer as compared to the national average, as well as lots of existing CCTVs which are not yet fully integrated across the province to support instant alert notification	> Municipalities > Provincial central office > Phuket Provincial Police

Shortlisted services	Service initiative	Initiative overview	Relevance to Phuket	Potential operators
Smart Tourism 	**Fully integrated tourist data management platform**	Platform with combined tourism database from both public and private sectors, accessible through user-friendly interface along with integrated advanced analytics to further optimize tourism-related services	Tourism is one of the major economic drivers for Phuket, however the province still lacks a collective data platform mainly due to the fact that sharing of tourism-related data among relevant entities are still very limited	> Municipalities > Appointed private company
	Mobile application for tourist experience enhancement	Mobile application combining all necessary functions, i.e., ride hailing service, journey planner, emergency contact channel and latest news/ updates, to facilitate smooth traveling experience in Phuket for visitors/ tourists	Phuket has more than twice the annual number of tourists than its own population, however the province still lacks a centralized service that is easily accessible by visitors/ tourists in order to facilitate smooth traveling experience	> Municipalities > Appointed private company
	Smart Immigration	Upgrade of current immigration process at the airport by implementing passport scanners, automated immigration barriers, AI-based facial recognition cameras, biometric scanners, online document storage system	Phuket has an increasing number of arriving international flights resulting in high number of reports on long immigration process from visitors/ tourists who need to be facilitated through the process more quickly with high security standard	> Phuket Immigration Bureau > Equipment provider

In addition to 9 service initiatives, we also need to ensure the readiness of the infrastructure to support the development of Smart City. From our Smart City framework, there are three important infrastructure components that can support the service scalability, operations and sustainability.

Connectivity – This infrastructure component will support the data transmission between installed sensors and operation centers, etc. to support the service operations. Connectivity is very important to support the service scalability. From the engagement with local stakeholders, Phuket currently lacks wide coverage of connectivity infrastructure in many areas which limits the service expansion across municipalities. Moreover, the existing connectivity does not provide consistent data transmission to ensure the service stability. We believe that there are some rooms to improve the connectivity across Phuket. The connectivity can range from Wi-Fi, LPWAN, 4G and last mile broadband coverage. The upgrade of connectivity will help prepare Phuket for the development of 9 service initiatives and support the provincial wide scalability in the long run.

Platform – This component is really important to support the development of Smart City ecosystem. Platform allows both small and large solution developers to plug in their solution to support soft launch/ trial run of the service. From global case studies, platform is usually open for all developers from startups, companies, etc. where they can allocate their budget to focus more on solution development instead of platform investment. We believe that Phuket should have an open single platform that will foster the ecosystem development and knowledge sharing between stakeholders

Data Center and other infrastructure – This component will support the installation of large data set to support data analytics for insights and future access to information by relevant stakeholders. Data center will play as a infrastructure of cloud computing development which can support long distance and real time data transmission and monitoring. Currently, data center has been developed by different stakeholders which can limit the seamless operations and single data source information. We believe that the set up of integrated data center will support the connected solution development which will be useful for data analytics and insights gathering.

From the engagement with local stakeholders and benchmarking with global case studies, there are some rooms for infrastructure improvement for Phuket. This improvement will foster the development of digital ecosystem and Smart City initiatives both in short and long term.

Smart Electric Metering – Electricity meters with advanced analytics for consumption monitoring purpose

Smart Electric Metering has increasingly been installed globally to monitor and record real time electricity consumptions so that customers can directly provide these information to the supplier in real time and better manage their electricity expenses. The service has been recognized for its success as it provides both residents and suppliers with savings on electricity bills and reduced operational costs respectively. Below is the service overview and issues expected to be addressed by the solution.

Service overview

Functions

Implementation of electronic meters equipped with advanced analytics to monitor and record real time electricity consumptions. Meters will measure and record electricity usage at intervals and automatically transmit the information to the electricity supplier for further monitoring. The supplier then makes these information available to customers on various types of user interface.

Benefits to key stakeholders

Residents – Savings on electricity bills due to the ability to monitor and control their electricity consumptions in real time
Electricity supplier – Savings on operational costs since meter recording and meter performance tracking can be done remotely without the need of travelling to customer sites to record readings and conduct regular check ups respectively

Required infrastructure/ component

Smart electricity meter – Electricity meter equipped with advanced analytics to measure and record electricity usage in real time
Sensor receptor – Receptor on the electricity supplier end to receive consumption information from customers
User interface – Electronic devices such as web portals, mobile application and in-home displays, installed at customer sites to display consumption information received from the supplier in a user friendly manner

Issues/ situation in Phuket

Current issues & situation in Phuket

Phuket has experienced a rapid increase in annual electricity consumption in the past years. Between 2013 and 2017, the annual consumption increased with 5.3% CAGR, approximately 2% higher than both national and Southern region growth rates. This total consumption amounted to 2,678 GWh in 2017, accounting for 16% of the total of Southern region. Phuket also has the fourth highest number of electricity customers in its region, with 202,977 customers in 2017. This figure is also projected to grow at faster rate than its neighboring provinces as Phuket has experienced an increase with 4.3% CAGR between 2013 and 2017, roughly twice the CAGR of other provinces. This is mainly because Phuket is a very popular tourist destination, leading to large number of tourism related businesses such as hotels and restaurants where electricity usage tend to be high to support their overall business operations.

"Electricity demand is starting to surpass supply due to increasing population with limited local capability in electricity generation"
– District Manager of depa

"With smart meters, authorities will be able to monitor real time consumption level and instantly issue alerts if there is likelihood of power outage especially during rainy seasons, leading to more cost savings"
- Vice President of Federation of Thai Industries

Smart Value Chain

We have developed value chain for the Smart Electricity Metering solution. This value chain will allow the existing service operator to understand on required key actions for both service set up and operations.

Service set up & development

Solution development

> Solution developer

Smart meter installation & maintenance

> Provincial Electricity Authority (PEA)
> Appointed private company

Smart service operations

Consumption information displaying

> Provincial Electricity Authority (PEA)

Payment collection

> Provincial Electricity Authority (PEA)

xxx = Public agencies

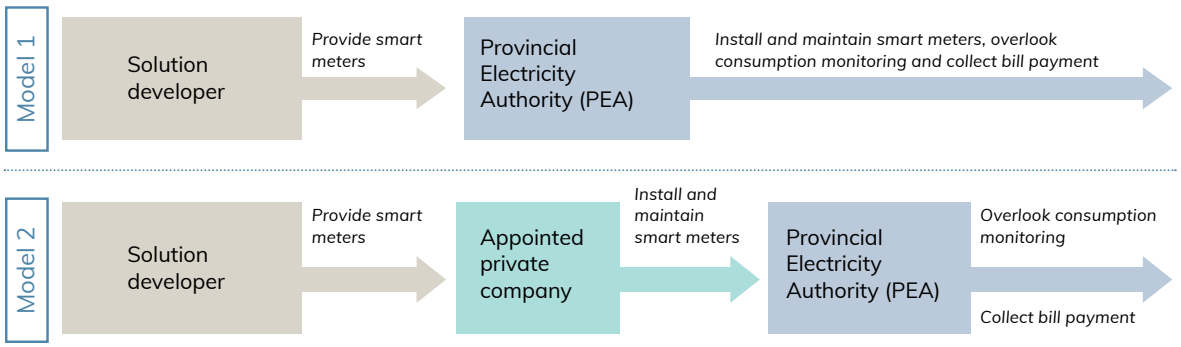
Source: Desktop Research, Roland Berger

Service operator role assessment

From the case studies, Smart Electricity Metering is generally operated by public party, specifically the electricity authority with responsibilities in each city, who also leverages software/ hardware provided by technology company when setting up the service. For Phuket, the only option for the service operator of Smart Electricity Metering is Provincial Electricity Authority (PEA) whose responsibilities lie from smart meter installation and maintenance all the way to payment collection from customers.

Business model options

In this section, we have developed two potential business models to operate Smart Electricity Metering service. The information has been gathered through primary and secondary research. These models are developed not only to support the service launch within Phuket, but also to support the service scalability and expansion to other provinces. From our study, the solution developer/ technology company will integrate regular electricity meters with advanced analytics and/ or other necessary technology in order to provide smart meters to PEA. From this point onwards, responsibilities of the service operation belong solely to PEA. However, there is an option for PEA to appoint part of its responsibilities to private companies to overlook smart meter installation and maintenance processes.



Action plans

A. Smart meter installation plan development
Assess requirements and actual demand for pilot launch by estimating how many customer sites are there within the area so that the total number of smart meters required for installation could be determined

B. Smart meter provider selection
Develop selection criteria such as product specifications, delivery timeline, price point, credentials, etc. and conduct vendor tendering process to select the most optimal smart meter provider who fits the pre-defined criteria

C. Smart meter procurement
Develop purchase agreement with the selected vendor, issue purchase order and procure smart meters from the selected vendor with quantity according to the estimated number in the installation plan

D. Trial run of service operations
Conduct trial run of the full service at a few locations to ensure smooth operations as well as connection between customer sites and supplier site

E. Training sessions for employees
Conduct training/ onboarding sessions for relevant employees of PEA in parallel, to prepare them for the full pilot launch of the service

F. Pilot launch and monitoring
Install smart meters at all required sites and initiate full operation including electricity consumption monitoring, payment collection and smart meter maintenance as well as monitor progress of the pilot to identify any pitfalls, bottlenecks and areas of improvement

G. Service expansion
Install smart meters at additional sites to increase coverage areas and expand the operation to achieve scalability

Timeline

Suggested investment model

Smart Traffic Light – Sensors with special algorithms/ AI for traffic flow optimization purpose

Smart Traffic Light has increasingly been installed worldwide to solve traffic congestion issue. The main use case is the use of sensors to monitor real time traffic flow at intersections and adjust traffic lights accordingly to ease traffic conditions, especially during rush hours. The service has been recognized for its success as it helps reduce the average traveling time for drivers, hence reducing traffic congestion hours. Below is the service overview and issues expected to be addressed by the solution.

Service overview

Functions

Installation of either in-ground vehicle detection sensors or sensors attached on traffic light system at each intersection to detect amount of approaching vehicles. These information will be further processed by the central control system which will automatically adjust traffic lights so that traffic congestions can be reduced.

Benefits to key stakeholders

Reduction in average traveling time for drivers, leading to improvement of driving experience due to increase in traffic flow as well as eventual reduction in duration of rush hour periods

Required infrastructure/ component

Sensor – In-ground vehicle detection sensors or attached sensors on traffic light system equipped with computerized algorithms and/ or artificial intelligence (AI) to detect and identify quantity of approaching vehicles at intersections as well as their speed and direction of travel

Central control system – Computerized control system in centralized control center to handle traffic data processing, analyze real time data and optimize traffic light signal

Traffic light system – Light signals at intersections that are optimized by automatically adjusting duration and frequency of both red and green lights in order that free flow of traffic could be achieved as much as possible

Issues/ situation in Phuket

Current issues & situation in Phuket

Heavy traffic congestion has been one of the key urban issues in Phuket. Over the past six years, Phuket has experienced a gradual increase in the total number of registered vehicles with approximately 3% CAGR and is also expected to increase at the same rate or slightly higher in the future. Moreover, the number of registered vehicles per capita in Phuket is also one of the highest in Thailand with approximately 1.19 vehicles per person. This figure is roughly twice the figure for national average of 0.60 vehicles per person, suggesting that there is currently a surplus amount of vehicles on the road which in turn is the main reason for traffic congestion issue. Furthermore, there has also been an increase in number of local complaints on heavy traffic congestion, especially during the high season periods due to the high influx of visitors and tourist.

"Smart Traffic Light will be able to help solve traffic congestion issue as it will optimize the timing of green light based on real time traffic flow detected by sensors and ensure synchronized traffic light at each intersection"
- Chief of Phuket Highway District

"Traffic during rush hour is very bad, as it currently takes too long to get to the other side of the island, we really need something to solve this issue"
– Driver in Phuket

Smart Value Chain

We have developed value chain for traffic flow optimization via the use of Smart Traffic Light solution. This value chain will allow the existing service operator to understand on required key actions for both service set up and operations.

Service set up & development			Smart service operations	
Solution development	Sensor installation & maintenance	Control center setup	Operation of control center	Operation of traffic lights
				
> Solution developer	> Municipalities > Phuket Highway District > Appointed private company	> Phuket Provincial Police > System integrator	> Phuket Provincial Police	> Phuket Provincial Police

xxx = Public agencies

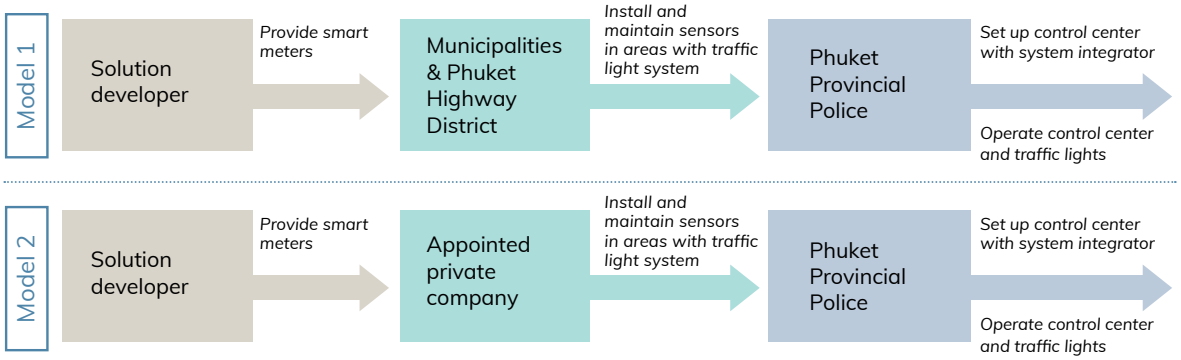
Source: Desktop Research, Roland Berger

Service operator role assessment

From the case studies, Smart Traffic Light is generally operated by the city council, specifically the division that overlooks urban transportation. The operator also leverages software/ hardware from technology company when setting up the service. For the case of traffic flow optimization via the use of Smart Traffic Light solution in Phuket, the only option for the service operator is Phuket Provincial Police whose responsibilities lie in traffic management, including operation of the control center and adjustment and control of traffic lights.

Business model options

In this section, we have developed two potential business models for traffic flow optimization via the use of Smart Traffic Light solution. The information has been gathered through primary and secondary research. These models are developed not only to support the service launch within Phuket, but also to support the service scalability and expansion beyond Phuket. Based on our study, sensors will be provided by the solution developer/ technology company. When it comes to installation and maintenance processes, there are two possible options. For the first option, these processes can be conducted in collaboration between relevant municipalities and Phuket Highway District. Municipalities will be responsible for sensors along roads within the urban areas while Phuket Highway District will be responsible for sensors along roads outside urban areas. If the operation of the service were to expand beyond Phuket in the future, Phuket Highway District will also need to be responsible for sensors along inter-city roads connecting to Phuket. On the other hand, there is also another option for both municipalities and Phuket Highway District to appoint their responsibilities to private company to overlook sensor installation and maintenance processes.



Action plans

A. Implementation plan development
Understand necessary requirements and regulations for pilot launch of the service and estimate the total number of locations that require Smart Traffic Light implementation by surveying the actual area so that the types and total number of required sensors could be determined

B. Sensor provider selection
Develop selection criteria such as product specifications, delivery timeline, price point, credentials, etc. and conduct vendor tendering process to select the most optimal sensor provider who fits the pre-defined criteria

C. Sensor procurement
Develop purchase agreement with the selected vendor, issue purchase order and procure sensors from the selected vendor with quantity for different types according to the estimation in the installation plan

D. System integrator selection
Develop selection criteria such as technological expertise, price point, concept understanding, past experience, etc. and conduct tendering process to select the most optimal system integrator who fits al

E. Control center setup
Integrate sensors at each traffic light system into a single control center, leveraging private lease line and/ or broadband so that real time traffic flow monitoring could be achieved

F. Trial run of service operations
Conduct trial run of the full service at a few locations to ensure smooth operations as well as connection between traffic light system and control center

G. Training sessions for employees
Conduct training/ onboarding sessions for relevant employees of Phuket Provincial Police in parallel, to prepare them for the full pilot launch of the service

H. Pilot launch and monitoring
Initiate full operation including operation of the control center and adjustment and control of traffic lights as well as monitor progress of the pilot to identify any pitfalls, bottlenecks and areas of improvement

I. Service expansion
Install additional sensors along inter-city roads beyond Phuket to increase coverage areas and expand the operation to achieve scalability

Timeline

Suggested investment model

Smart Traffic Light – Cameras for monitoring of traffic law violations by drivers and motorists

Another use case of Smart Traffic Light is to use attached cameras to monitor the traveling speed of approaching vehicles at intersections and trigger fines to motorists with traffic law violations. The service has been recognized for its success as it helps reduce the average traveling time for drivers, hence reducing traffic congestion hours. Below is the service overview and issues expected to be addressed by the solution.

Service overview

Functions

Installation of cameras attached on traffic light system that can monitor vehicles' speed and identify vehicles' license plates. The detected information will be transmitted to the control center and will be further processed by the central control system. The system will be able to pinpoint owners of vehicles with detected license plates, leveraging database of registered vehicles within the province, and then automatically trigger fines to those that have violated traffic laws, i.e., not wearing helmets, running red lights and speeding.

Benefits to key stakeholders

Ability to closely monitor and enforce speed limits in areas throughout the province, leading to reduction in number of traffic violation cases as well as increased public safety

Required infrastructure/ component

Camera – Attached cameras on traffic light system to closely monitor vehicles' speed and direction of travel as well as detect and identify license plates of vehicles with traffic violations

Central control system – Computerized control system in centralized control center equipped with database on registered vehicles in Phuket to process real time traffic data and automatically trigger fines to owners of vehicles that have violated traffic laws based on identified license plates

Issues/ situation in Phuket

Current issues & situation in Phuket

Heavy traffic congestion has been one of the major problems for Phuket and is expected to remain as the key issue in the future. This is due to the fact that the total number of registered vehicles in the province has been growing steadily and is also projected to grow at the same rate or slightly higher in the future. With this, there will also be another problem which follows as a result of traffic congestion, the increase in the number of traffic law violations. In 2016, 33% of total road accidents in Phuket are caused by violating the speed limit. This figure has been higher than the figure for national average and is also expected to keep growing in the future. This illustrates the need for solutions that can closely monitor vehicle speed and hence, reduce the number of road accidents. Furthermore, there has also been an increase in number of local complaints on motorists not wearing helmets while riding, leading to increase in number of road accidents as well.

"I have witnessed many motorists not wearing helmets while riding, this should not become the norm"
– Resident in Phuket

"Most claims in Phuket stem from incidents with road accidents caused by traffic law violations"
– Product Manager of Southeast Insurance

Smart Value Chain

We have developed value chain for traffic flow optimization via the use of Smart Traffic Light solution. This value chain will allow the existing service operator to understand on required key actions for both service set up and operations.

Service set up & development			Smart service operations	
Solution development	Camera installation & maintenance	Control center setup	Operation of control center	Fines issuing
				
> Solution developer	> Municipalities > Phuket Highway District > Appointed private company	> Phuket Provincial Police > System integrator	> Phuket Provincial Police	> Phuket Provincial Police

xxx = Public agencies

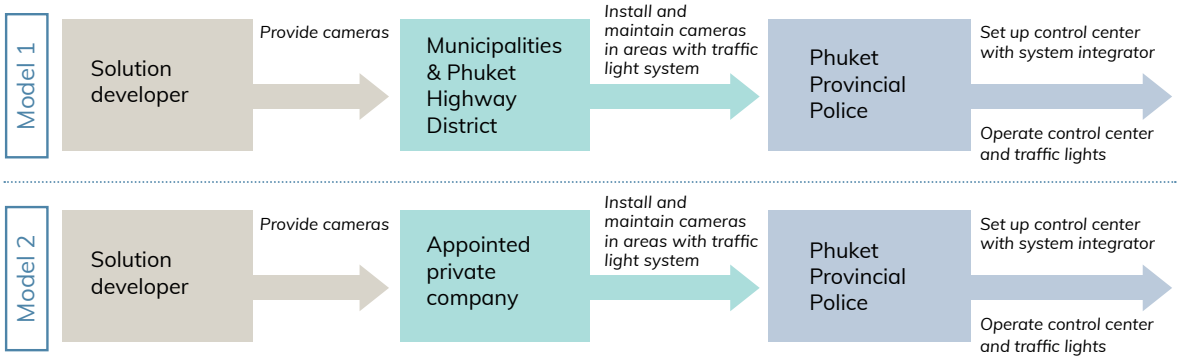
Source: Desktop Research, Roland Berger

Service operator role assessment

From the case studies, Smart Traffic Light is generally operated by the city council, specifically the division that overlooks urban transportation. The operator also leverages software/ hardware from technology company when setting up the service. For the case of traffic law violations monitoring via the use of Smart Traffic Light solution in Phuket, the only option for the service operator is Phuket Provincial Police whose responsibilities lie in traffic management, including operation of the control center and traffic fines issuing to relevant vehicle owners.

Business model options

In this section, we have developed two potential business models for traffic law violations monitoring via the use of Smart Traffic Light solution. The information has been gathered through primary and secondary research. These models are developed not only to support the service launch within Phuket, but also to prepare for the service expansion to other provinces. Based on our study, cameras to be attached on traffic light system, acting as detectors, will be provided by the solution developer/ technology company. There are currently two possible options regarding the installation and maintenance of these cameras. This could be done by either relevant municipalities in collaboration with Phuket Highway District or by appointed private company. For the first option, relevant municipalities will be responsible for cameras along roads within the urban areas while Phuket Highway District will be responsible for cameras along roads outside urban areas. In case of further expansion of the service beyond Phuket, Phuket Highway District will need to be responsible for installing and maintaining cameras along inter-city roads connecting to Phuket as well. On the other hand, the second option will be for both municipalities and Phuket Highway District to appoint their responsibilities to private company to overlook camera installation and maintenance processes.



Action plans

A. Implementation plan development
Understand necessary requirements and regulations for pilot launch of the service and estimate the total number of locations that require cameras to be implemented by surveying the areas, especially those with history as well as high likelihood of road accidents so that the types and total number of required cameras could be determined

B. Vendor selection
Develop selection criteria such as product specifications, delivery timeline, price point, credentials, etc. and conduct vendor tendering process to select the most optimal camera provider who fits the pre-defined criteria

C. Camera procurement
Develop purchase agreement with the selected vendor, issue purchase order and procure cameras from the selected vendor with quantity for different types according to the estimation in the installation plan

D. System integrator selection
Develop selection criteria such as technological expertise, price point, concept understanding, past experience, etc. and conduct tendering process to select the most optimal system integrator who fits all the criteria

E. Control center setup
Integrate cameras at each traffic light system into a single control center, leveraging private lease line and/ or broadband so that real time traffic footage and incidents of traffic law violations could be monitored

F. Trial run of service operations
Conduct trial run of the full service at a few locations to ensure smooth operations as well as connection between traffic light system and control center

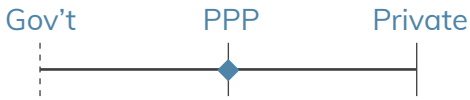
G. Training sessions for employees
Conduct training/ onboarding sessions for relevant employees of Phuket Provincial Police in parallel, to prepare them for the full pilot launch of the service

H. Pilot launch and monitoring
Initiate full operation including operation of the control center and traffic fines issuing as well as monitor progress of the pilot to identify any pitfalls, bottlenecks and areas of improvement

I. Service expansion
Install additional cameras along inter-city roads beyond Phuket to increase coverage areas and expand the operation to achieve scalability

Timeline

Suggested investment model



Smart Public Transport – Collective digital platform with multi-modal mobility solutions for public transport

Smart Public Transport has increasingly been implemented around the world to better facilitate commuters within the city and increase urban accessibility through the encouragement of public transport usage so that private vehicle usage could be reduced. The service has been recognized for its success as it reduces traffic congestion level as well as improve commuters' travel experience within the city. Below is the service overview and issues expected to be addressed by the solution.

Service overview

Functions

Centralized platform for commuters with a wide range of public transport modes and demand responsive mobility solutions that facilitates the end-to-end process of public transport usage. The platform, which is linked to various public transport operators, will be able to provide real time information on all publicly available mobility services so that commuters can plan their journeys in advance, make immediate bookings and pay for their trips within a single platform

Benefits to key stakeholders

Reduction in traffic congestion level since commuters will depend less on private vehicles, leading to improved air quality due to lower environmental emissions from lower number of vehicles on the road as well as improved commuters' travel experience

Required infrastructure/ component

User interface – Mobile application with user-friendly interface for commuters to plan their journey, make bookings and pay for their trips

Data source – Real time data on public transport schedule, vehicle exact locations, pricing and booking availabilities provided by various public transport operators available within the city

Issues/ situation in Phuket

Current issues & situation in Phuket

Heavy traffic congestion has been one of the key issues for Phuket and is also expected to remain the same in the near future. Over the past six years, there has been a gradual increase in the total number of registered vehicles with a growth rate of 3% CAGR. Furthermore, the number of registered vehicles per capita is also among the highest in Thailand with approximately 1.19 vehicles per person and is roughly twice the national average figure of 0.60 vehicles per person. These are key reasons for the high volume of vehicles on the road, causing high level of traffic congestions and long period of peak hours. In terms of public transport network, there is also currently limited amount of real time information regarding public transport available online which proves to be difficult for tourists/visitors. Hence, there is a need for a solution that centralizes real time information of all public transport modes to facilitate and eventually encourage the usage of public transport for commuters.

"Heavy traffic congestion is very common in Phuket and is definitely the number one urban problem that needs to be solved quickly" – Chief of Phuket Highway District

"It is very inconvenient for me to approach and ask locals about bus/Songthaew routes, since there's hardly any information available online in English" – Tourist in Phuket

Smart Value Chain

We have developed value chain for Smart Public Transport solution. This value chain will allow the existing service operator to understand on required key actions for both service set up and operations.

Service set up & development		Smart service operations	
Application development	Partnership establishment	Operation & maintenance	Software updates
			
> Solution developer	> Public transport operators > Phuket Land Transport Office > Appointed private company	> Phuket Land Transport Office > Appointed private company	> Phuket Land Transport Office > Appointed private company

xxx = Public agencies

Source: Desktop Research, Roland Berger

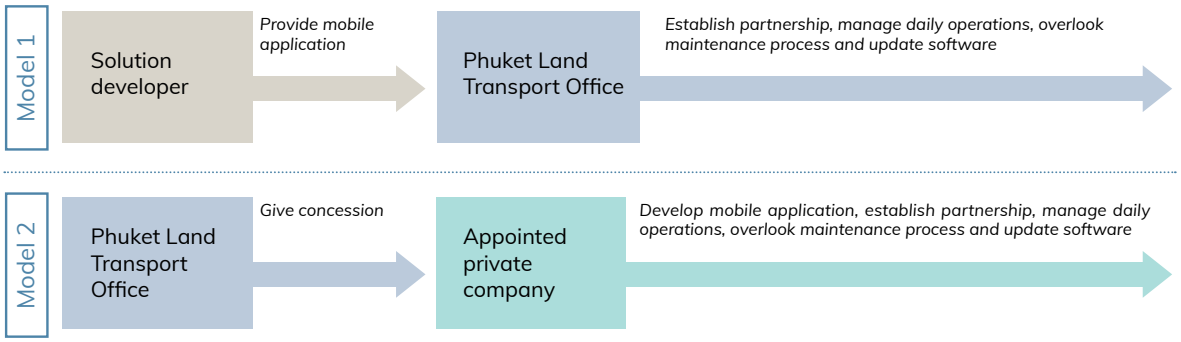
Service operator role assessment

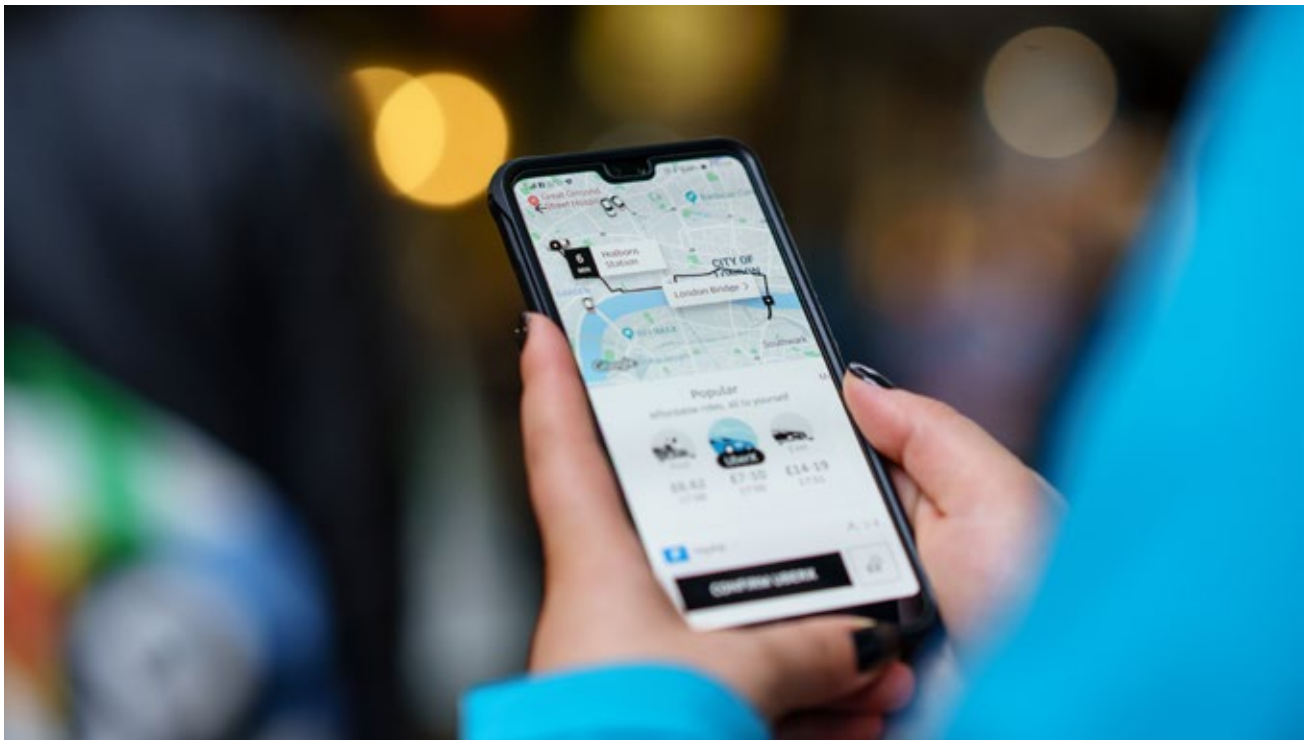
From observing the case studies, Smart Public Transport can either be operated by relevant department/ division of the local government leveraging mobile application provided by solution developer or by private concessionaire directly appointed by the local government. For Phuket, the relevant public party who has the potential to be the service operator is Phuket Land Transport Office whose responsibilities lie from establishing partnership with various public transport operators and managing daily operations. We have conducted the assessment to understand pros and cons of each operator type.

	Description	Pros	Cons
Phuket Land Transport Office	> Conduct all operational activities, however mobile application development may be outsourced to private solution developer	> Complete control of service operations and offerings > Smooth partnership establishment process with public transport operators due to existing connections	> Lack of expertise and experience in mobile application operation, leading to limited incentive to offer better service
Appointed private company	> Receive appointment or contract from Phuket Land Transport Office to develop, operate and maintain the solution on behalf of the local government	> Direct expertise in mobile application development, operation and maintenance > Ability for local government to select from the pool of experienced solution developers and operators (concession system can provide incentive to continuously improve service)	> Difficulty in establishing partnership with public transport operators due to lack of connections

Business model options

In this section, we have developed two potential business models to operate Smart Public Transport service. The information has been gathered through primary and secondary research. These models are developed not only to support the service launch within Phuket, but also to support the service scalability and expansion to other provinces. For the first model, the solution developer/ technology company will provide mobile application based on requirements from Phuket Land Transport Office. The full operation, including maintenance, will be fully taken over by Phuket Land Transport Office, potentially by internal IT team. For the second model, concession will be given to private company selected from pool of experienced developers/ operators. The appointed private company will have a full ownership of mobile application and is therefore responsible for end-to-end process of the service including mobile application development, daily operations and maintenance as well as software updates.





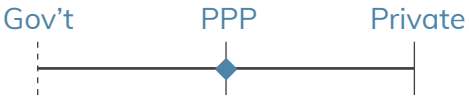
Action plans

A. Mobile application requirement development
Define vision and objective of mobile application and gather all requirements to develop a list of mobile application features
B. Developer (Model 1)/ concessionaire (Model 2) selection
Develop selection criteria such as concept comprehension, expertise and capability, delivery timeline, price point, portfolio and credentials, etc. and conduct tendering process to select the most optimal player who fits the pre-defined criteria
C. Mobile application development
Develop mobile application based on requirements and regularly liaise with developer/ concessionaire to monitor progress
D. Partnership establishment
Conduct capability assessment for public transport operators in parallel in order to develop a shortlist of potential partners, approach them to present concept and establish partnership upon the execution of agreement on public transport data sharing
E. Trial run of service operations
Conduct internal testing and user acceptance test to ensure smooth operations as well as connection between mobile application and data sources from public transport operators
F. Pilot launch and monitoring
Launch mobile application on App Store, initiate full operation and monitor progress to identify any pitfalls and areas of improvement
G. Software updates
Gather all key observations obtained during regular monitoring in order to constantly fix and update mobile application so that and high quality of service operations could be achieved

Timeline

2020 2021 2022 2023

Suggested investment model



Smart Waste Management – Waste collection sensors with integrated route planning system

Smart Waste Management has been implemented worldwide to support municipalities and other related public agencies to provide more efficient waste collection and treatment processes. Smart Waste Management has been recognized for its success as it reduces the amount of uncollected waste and provides cost savings due to optimization of rubbish trucks utilization as a result of advanced route planning. Below is the service overview and issues expected to be addressed by the solution.

Service overview

Functions

Installation of sensors on trash bins to measure and track waste level. Sensors will send alerts to the operation center of the operator when bins are nearly full. This solution will also provide route planning optimization to help the operator plans rubbish truck and resources for the waste collection and treatment processes.

Benefits to key stakeholders

Residents – Reduction of overfilling bin issues and other related waste pollution in residential areas
Service operator – Increase in waste collection/ pick up efficiency, better resource planning and reduction of operational costs from advanced route planning application

Required infrastructure/ component

Trash bin and rubbish truck – Key infrastructure to provide waste collection/ treatment service
Sensor – Sensors attached on trash bins that collect real time data of waste level in order to provide optimal pick up time for service operator
Sensor receptor/ network gateway – Receptor on the service operator end to receive alerts from installed sensors
Cloud computing – System with ability to conduct data analytics, acting as storage of data sent by installed sensors
User interface – Formulation of results/ insights from data analytics

Issues/ situation in Phuket

Current issues & situation in Phuket

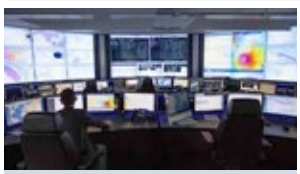
Phuket has high volume of generated waste due to growth in population and tourists. Generated waste in Phuket has increased over 5% within the past 6 years. Moreover, Phuket has high volume of annual generated waste per capita as compared to other key provinces and national average. In addition, municipalities do not have clear visibility on waste level to provide waste collection service. Residents also occasionally experience pollution caused by untreated and uncollected waste due to the fact that there is still a very limited coverage of trash bins in remote areas of the province. Finally, Phuket only has capacity to dispose 700 tons of waste per day and also does not have enough landfill to support the treatment process of the leftover waste.

> *"Waste level has been increasing dramatically in Patong's coastal area since I have frequently witnessed overfilling bins along the beach"*
> *– Resident in Phuket*

> *"Overfilling bins and collected waste have been improved recently after we have launched the service, and we hope to scale this throughout the province in the future too"*
> *– Founder of D-Kids*

Smart Value Chain

We have developed value chain for Smart Waste Management solution. This value chain will allow the existing service operator to understand on required key actions for both service set up and operations

Service set up & development		Smart service operations	
Solution development	Service set up & maintenance	Operation center development	Waste collection & treatment
			
> Solution developer	> Solution developer	> Municipalities > Appointed private company	> Municipalities > Appointed private company

xxx = Public agencies
Source: Desktop Research, Roland Berger

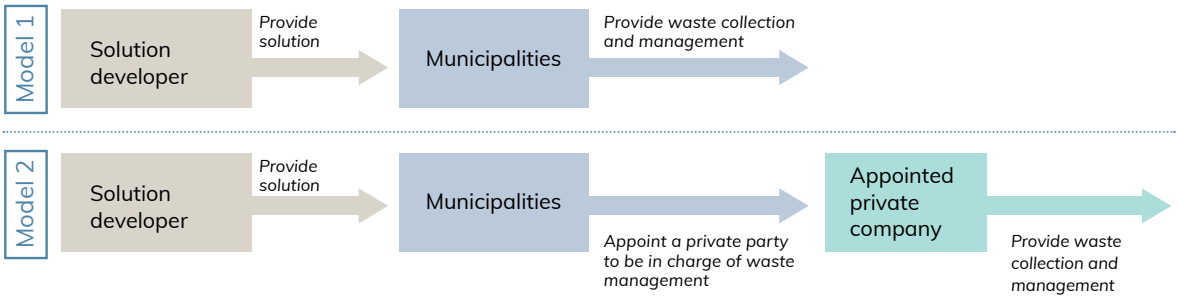
Service operator role assessment

From the case studies, Smart Waste Management is usually operated by municipality or an appointed private party. We have conducted the assessment to understand pros and cons of each operator type.

	Description	Pros	Cons
Municipalities	> Leverage available rubbish trucks and resources to carry out waste collection and management as well as manage operation center on a daily basis	> Possibility to leverage existing connection with other municipalities to expand service coverage throughout the province	> Limited availability of budget and resources to expand service coverage
Appointed private company	> Receive appointment or contract from municipalities to manage the solution, operation center and waste collection and treatment	> Strong incentive to provide high quality and consistent services to maintain contract with the government	> Permission from public agencies for infrastructure access and service expansion across municipalities required

Business model options

In this section, we will focus on business model, and proposed development timeline in order to support launch of this initiative. This service initiative will be financed/ paid by the municipality to support the service setup and operations. Currently, municipality is responsible for waste collection and treatment processes. The service initiative is expected to help municipality manage waste collection more efficiently. Municipality can also appoint service operation to a private party by granting with permission/ contract to allow the private party to manage everything from operation center management to waste collection and treatment. Based on global case studies, there are different pricing options that can be charged by the private party to the municipality.



Pricing options

In case that the municipality wants to appoint the waste collection and management to a private party (Model 2), there are two different pricing options available.

Fixed service fee – A fixed fee charged by the appointed private party that can possibly be charged on a monthly or yearly basis. Waste volume will not be accounted in this option.

Percentage of collected waste volume – Revenue depends on volume of collected and managed waste which can be varied over time period To ensure Phuket receives the most benefit, percentage of collected waste volume would be more suitable as it provides strong incentive for the private party to increase waste collection efficiency as their revenue depends on volume of collected waste.

Action plans

A. Service readiness assessment to support quick-win
Assess the availability of dedicated waste collection points to support sensor installation, focusing on potential areas for high number of sensors as the quick-win launch to be done by either municipality or appointed private company, in order to assess the feasibility of the service

B. Quick-win feasibility analysis
Conduct analysis on environmental benefits provided to the city as a result of the quick-win launch such as number of overfilling bins, volume of uncollected waste and number of reported case from waste pollution during quick-win launch to determine if the service has the potential for expansion

C. Setup of dedicated team
Set up a dedicated team to support future service expansion study and operation center management to monitor waste level and perform route planning for waste collection

D. Service expansion study
Assess areas that have high waste problems and supporting infrastructure to support the second priority and future launch, to be carried out by municipality as it has advantages to assess or gather information from other public agencies

E. Service assessment and monitoring
Assess and monitor launch areas to determine the service sustainability based on environmental benefits provided by the solution as well as to determine if the service should be scaled up or down based on as-is issues and current situation of the area

Timeline

Suggested investment model

Integrated CCTV System – Fully integrated CCTVs with facial recognition ability for public safety enhancement

Integrated CCTV System has been implemented to enhance the security and monitoring coverage of municipalities, police officers and other security related officers. The system provides instant alerts to responsible officers which can help prevent bad incidents. Advanced features of Integrated CCTV System can also help predict unusual behaviors such as facial and movement recognition. Below is the service overview and issues expected to be addressed by the solution.

Service overview

Functions

Integration of all CCTVs along with integrated solutions such as facial and behavior recognition to a single command center in order to collect real time information and provide instant alerts to responsible officers to address the situation

Benefits to key stakeholders

Residents – Enhanced safety for tourists and locals as the system helps identify immediate on-the-scene detection and provides alerts to nearby police officers

Service operator – Ability for quick decision making due to multiple sources of information directly linked to the command center and instant collaboration feature with other related parties to efficiently minimize losses and enhance safety

Required infrastructure/ component

Digital CCTV – CCTV to monitor and detect unusual behaviors throughout the province, especially in areas with low police officer coverage

Broadband connectivity – Network of broadband to support real time monitoring as the connectivity can provide continuous and large files transmission from installed CCTVs to the command center

Data center – Storage of video files to support future instant file retrieving

Command center – Centralized center to monitor all CCTVs in real time and provide alerts to other related security officers

Issues/ situation in Phuket

Current issues & situation in Phuket

Integrated CCTV System can enhance safety for locals and tourists in Phuket. Moreover, it can support officers such as police officers to monitor the wide area of Phuket. Based on the secondary research, Phuket has higher number of population to a police officer as compared to the national figure. Phuket currently has around 2,000 CCTVs, however they are not yet fully integrated which can somewhat limit instant response to address unusual activities. Many local stakeholders in Phuket have shared similar message that Phuket can still further improve the coverage of number of CCTVs throughout different municipalities. Number of visitors in Phuket has also been increasing over years, emphasizing the need for improved public safety.

"CCTVs are not yet fully integrated and we need a central entity to drive CCTV integration across Phuket as well as provide both service operations and maintenance"
– Chief of Phuket Regional Office, Department of Disaster Prevention and Mitigation

"After we have integrated our installed CCTVs into our one single command center, we have seen an improvement in our operations with police officers, resulting in reduction of crime rates"
– Deputy Mayor of Kathu Town Municipality

Smart Value Chain

We have developed value chain for Integrated CCTV System with facial recognition. This value chain will allow the existing service operator to understand on required key actions for both service set up and operations

Service set up & development

Solution development	CCTV installation and maintenance	Integration of CCTVs to command center
		
> Solution developer	> Municipalities > Provincial central office[1)]	> Municipalities > Provincial central office[1)]

Smart service operations

Operation of command center	Alerts notification
	
> Municipalities > Provincial central office[1)] > Phuket Provincial Police	> Municipalities > Provincial central office[1)] > Phuket Provincial Police

xxx = Public agencies

1) Department under Phuket Province that is responsible for safety management throughout the province

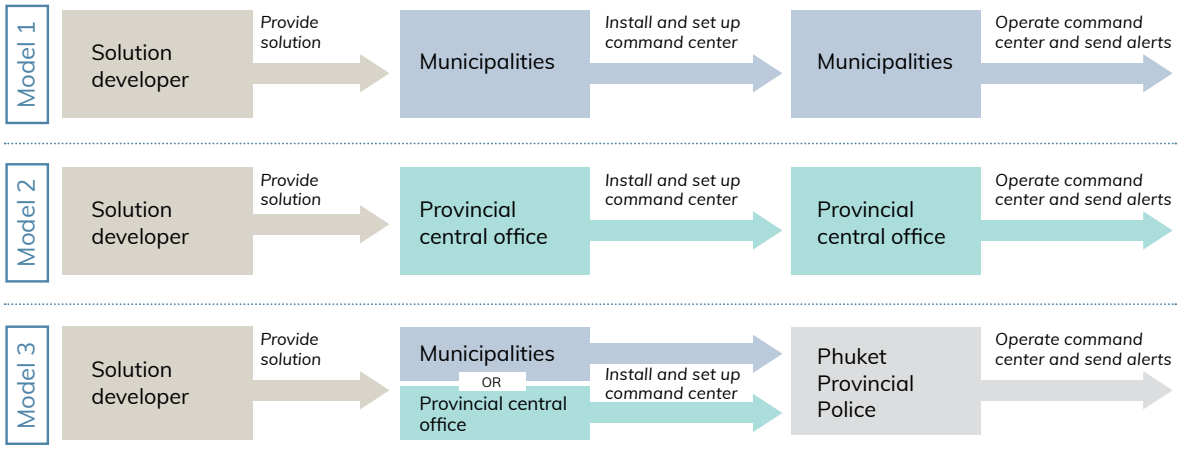
Service operator role assessment

Based on our studies, Integrated CCTV System can be operated by municipalities, provincial central office (department under Phuket Province that is responsible for safety management) or Phuket Provincial Police. We have conducted the assessment to understand pros and cons of each type:

	Description	Pros	Cons
Municipalities	> Integrate CCTVs into a single command center which will be operated by municipality officers	> Immediate responses due to less area coverage, in-depth understanding of the area and close connection with local police officers	> Inconsistency in level of provided security across the province since each municipality will have its own system which might not be uniform across all municipalities
Provincial central office	> Integrate provincial wide CCTVs into a centralized office such as Phuket City Hall to monitor and operate command center of CCTVs in the province	> Consistency in level of provided security across the province as all installed CCTVs are fully integrated into one command center	> Large area coverage and less in depth understanding on the areas as compared to individual municipality throughout the Phuket
Phuket Provincial Police	> Grant access of command center and integrated CCTVs network from municipality or provincial central office	> Immediate responses to investigate at risk areas which can minimize/ prevent bad incidents to locals and tourists	> Approval for service maintenance/ development from municipality/ provincial central office required since they are the entities that support on budget allocation

Business model options

In this section, we have developed three potential business models for operating integrated CCTV initiative. The information has been gathered through primary and secondary research. These models can be developed not only to support the Phuket launch, but also to support the service scalability across provinces. From our study, a municipality or a provincial central office should take lead in the CCTV installation and command center setup due to budget availability, in-depth understanding of the area, strong incentive to improve responsible area and close connection with other stakeholders to launch the initiative successfully. But during the service operations, both municipality and provincial central office can operate the service by themselves or grant access to Phuket Provincial Police for them to be in charge of service operations and management.



Action plans

A. CCTV point installation and upgrade analysis
Assess the location on where to install additional CCTVs and if existing CCTVs are required to be upgraded in order to support the single command center integration

B. Roll-out and upgrade of CCTVs across planned locations
Procure CCTVs and solution to support the service roll-out across the planned location to be carried out in collaboration between municipality/ provincial central office and solution provider

C. Integration of CCTVs to a single command center
Roll out private lease line or broadband to connect CCTVs into a single command center to support real time monitoring and alerts notification

D. Formulation of alerts notification network
Develop close network connection and communication system with relevant parties to support instant alerts sending

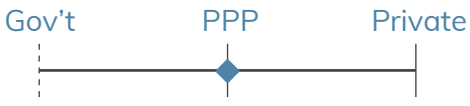
E. Trial run of operations center and alert notification
Formulate dedicated team to conduct trial run analysis on command center management and alerts notification, which can be conducted in a close environment to analyze gaps of current process and capabilities so that these issues could be addressed prior to the full launch of the initiative

F. Service launch and monitoring
Operate the command center or grant access to Phuket Provincial Police for the service operations as well as provide service monitoring and maintenance when needed

Timeline

2020 → 2021 → 2022 → 2023

Suggested investment model



Smart Tourism – Fully integrated tourist data management platform

Smart tourism has a wide range of potential service initiatives that could benefit Phuket. One of them is the collective data platform consisting all tourism-related data from various entities within Phuket. The service has been recognized for its success as it allows better policymaking as well as process optimization of tourism-related services based on collected information on tourist behavior in the province. Below is the service overview and issues expected to be addressed by the solution.

Service overview

Functions

Platform with combined tourism-related database from both public sector, e.g., Phuket Airport, municipalities, Marine Department, etc., as well as private sector, e.g., Thai Hotels Association, Phuket Tourist Association, etc., where all data are accessible through a single easy-to-use interface. Data analytics will also be employed to better understand tourists behavior in order to more efficiently tackle relevant issues such as how to extend stay period, where is the top spending area, etc.

Benefits to key stakeholders

Local government agencies/ service operator – Better policymaking and allocation of resources, e.g., waste management, security, as well as more direct identification of problems and efficient information keeping

Local businesses – Better understanding of tourist behavior for business and better collaboration/ knowledge transfer between public and private sectors

Required infrastructure/ component

Cloud computing – System for storage of data from both different agencies and those collected by installed sensors to support data analytics

User interface – Computerized platform to be used by all agencies and businesses for data sharing and analytics

Security system – System to ensure data security and different levels of authorized access to information (Governor may have full access to all information, whereas local businesses may have access to only information related to them)

Command center – Centralized center to monitor all CCTVs in real time and provide alerts to other related security officers

Issues/ situation in Phuket

Current issues & situation in Phuket

One of Phuket's largest income sources is the tourism sector. In order to sustain the growth in income from this sector, a better understanding of the trends and behavior is important. Since all public agencies are currently conducting data keeping separately, this leads to low transparency between different entities and duplicated works at times. Moreover, there is also little analytics of collected data as well as limited data sharing between local businesses. Public agencies are also concerned with data security, preventing a more transparent network of data sharing. To sum up, there is no single entity who is in charge of managing and compiling all data from different agencies, a role which Phuket needs and will greatly benefit from.

"It is extremely difficult to integrate data from different municipalities and agencies as there are concerns regarding data security"
– Mayor of Phuket City Municipality

"Most public agencies still conduct record keeping on paper, however if we want to facilitate better data sharing, we need to turn them into electronic records first"
– District Manager of depa

Smart Value Chain

We have developed value chain for fully integrated tourist data management platform solution. This value chain will allow the existing service operator to understand the required key actions for both service set up and operations

Service set up & development		Smart service operations	
Solution development	Service set up & maintenance	Installation of user interface	Data collection & analytics
			
> Solution developer	> Solution developer	> Municipalities > Appointed private company	> Municipalities > Appointed private company

xxx = Public agencies

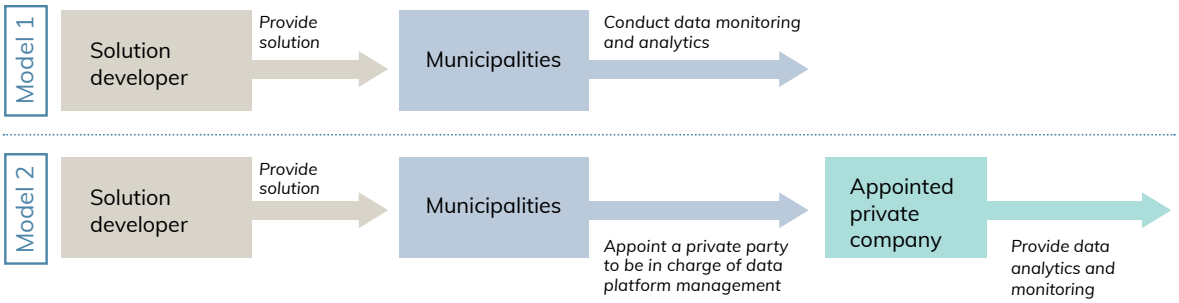
Service operator role assessment

From observing international case studies, integrated tourist data management platform is usually operated by a local government agency, in collaboration with a technology provider or by an appointed private party. We have conducted the assessment to understand pros and cons of each operator type

	Description	Pros	Cons
Municipalities & solution provider	> Conduct all data analytics and monitoring, while the platform is maintained by the technology provider who does not have access to data	> Complete data security since other entities will not have access unless authorized by related officials	> Depth of data analytics may be limited to the capability and expertise of responsible agencies
Appointed private company	> Receive appointment or contract from municipalities to manage the solution, conduct data analytics and report results to related agencies	> Ability for local government to select from the best available private companies with expertise and experience to deliver high quality analytics and data management	> Systematic security measure must be enforced to ensure confidentiality since a private third party has access to data and information belonging to the government

Business model options

In this section, we will discuss two potential business model options. Considering the pros and cons of each model, the model of choice would be the second model, where a private party is appointed to monitor data and conducts analytics. This is because the government agency in charge can select the most optimal and suitable private company from a large pool of skills and expertise, giving them the best and most capable provider available. Concerns regarding data security can be addressed by establishing a system whereby only approved sets of data are visible to the private party for analysis. A non-disclosure agreement can also be issued to the appointed private company to ensure confidentiality.



Action plans

A. Selection of private parties for partnership
Launch a TOR to find the most suitable private party with ample experience and good track record in the field, who will operate the service and conduct data analytics

B. Development of solution compatible and specific to Phuket
Arrange meetings with local public agencies to understand their needs and how they are currently undertaking record keeping to ensure that the developed system serves the needs of the local agencies

C. Setup of user interface at related agencies' offices
Install the program at government agencies' offices, targeting those who would primarily benefit and have the data to contribute to the pool of information, as well as set up and organize training sessions for staff on how to use the program

D. Consolidation and collection of data
Collect data and ensure that they are sorted into one single format, ready to be analyzed (sensitive data which the government would like to keep confidential from private parties can be opted out at this stage)

E. Data analytics to create useful insights for local agencies and businesses
Conduct data analytics by service provider, under the supervision of the public agency in charge, in the direction specified in order to obtain insights needed at that moment in time, which will address current problems or opportunities brought upon Phuket

F. Sharing of insights and data collected with selected entities
Grant access to collected data and insights to related agencies and develop action plans by the government in order to tackle problems or address any opportunities identified from the analyzed data

Timeline

Suggested investment model

Smart Tourism – Mobile application for tourist experience enhancement

The next potential service initiative is mobile application to enhance tourist experience in Phuket. The service has been recognized for its success as it centralizes all necessary functions for tourists in one place, ensuring hassle-free experience in the province. Below is the service overview and issues expected to be addressed by the solution.

Service overview

Functions

Mobile application combining all necessary functions to facilitate a smooth travelling experience in Phuket, available in multiple languages. This application will combine ride hailing service function for hailing taxis and accurately locating pick-up point, journey planner function with a map feature catered to transportation modes in Phuket, emergency contact channel allowing rescuers to reach user's location swiftly, and latest news/ updates function for to update tourists with news and up-to-date information on events and attraction guides from local entities

Benefits to key stakeholders

Tourists – Smoother and hassle-free traveling experience in Phuket
Local government agencies – Ability to accurately locate users and notify them of any news, warnings or events for public safety enhancement purpose
Service operator – Opportunity to receive concession from the government as well as potential financial return received from local businesses who may want to advertise their services or products on the mobile application
Local businesses – Improved public visibility and reputation via the opportunity to advertise their services/ businesses to tourists

Required infrastructure/ component

Mobile application – Centralized platform developed by the service provider
Network connection with taxi company – Platform connecting to taxi operators
Emergency response system – Terminal installed at various emergency response centers to allow users to notify rescuers in case of emergencies

Issues/ situation in Phuket

Current issues & situation in Phuket

Phuket has more than twice the annual number of tourists than its own population. However the province still lacks a centralized service to facilitate smooth traveling experience. The current network of public transport is not very extensive and taxis are extremely hard to come by as well as expensive. Various attractions are also dispersed, making it difficult for foreigners to plan their journey, especially with the limited understanding of local language. Although there are many road and marine accidents within the province, there is currently no efficient and foreigner-friendly channel to call for help in case of emergency. Lastly, even though there are already initiatives to tackle mentioned issues, they are still developed individually by private companies, rather than being combined into one single platform, thus making it difficult for tourists to pick and choose.

"Safety of tourists is our top priority as we cannot afford another tragic incident, otherwise foreigners would head elsewhere"
– President of Phuket Tourist Association

"It is difficult for tourists to get around Phuket as they are not aware of the available options, and taxis can also be quite expensive for long distance"
– General Manager, Renaissance Phuket Resort & Spa

Smart Value Chain

We have developed value chain for tourist experience enhancement mobile application. This value chain will allow the existing service operator to understand the required key actions for both service set up and operations

Service set up & development		Smart service operations	
Application development	Partnership establishment	Operation and maintenance	Emergency response alert system
			
> Solution developer	> Municipalities > Solution developer	> Municipalities > Appointed private company	> Municipalities > Appointed private company

xxx = Public agencies

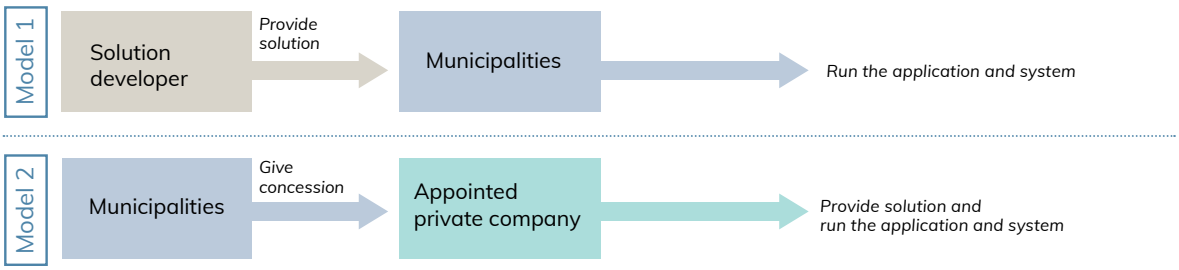
Service operator role assessment

From observing international case studies, Mobile Solution to Enhance Tourist Experience is either operated by a local government agency or by a private concessionaire. We have conducted the assessment to understand pros and cons of each operator type

	Description	Pros	Cons
Municipalities & solution provider	> Conduct all operational activities, however application development may be outsourced to related IT public agency	> Complete control over the activity and offerings of the application as well as direct partnership with related stakeholders, e.g., taxi company and emergency response unit	> Lack of expertise and experience in mobile application operation, leading to limited incentive to offer better service
Appointed private company	> Receive appointment or contract from municipalities to manage the solution, deal with taxi company and emergency response unit on the government's behalf	> Ability for local government to select from the pool of experienced solution developers and operators (concession system can provide incentive to continuously improve service)	> Less control over activities of the solution since the local government no longer directly deals with related stakeholders

Business model options

In this section, we will discuss two business model options for this service initiative. Considering the pros and cons of each model, the model of choice would be the second model, where a private concessionaire is appointed to operate and maintain the mobile solution. This is because the government agency in charge can select private sectors from a large pool of skills and expertise, giving them the best and most capable provider available. There is minimal sensitive data or information, therefore even if the government has limited control over the solution, as long as it serves the purpose, all parties will benefit. Contracts can be written in mid-term length so that after a period of time, if the concessionaire cannot satisfy the needs of the government, a new one can be appointed.



Action plans

A. Selection of private concessionaire
Launch a TOR to find the most suitable private party with strong experience and good track record in the field, who will operate the service

B. Development of partnership with at least a taxi company
Select a taxi company or multiple companies to establish partnership with as ride hailing will be one of the main functions of the mobile application (selection should be done on the basis of price competitiveness and service quality)

C. Establishment of working protocol with emergency response department
Work with Phuket Provincial Police, Tourist Police Bureau and any other rescue units to establish a protocol on how tourists can send alerts for help and how the rescuer should respond

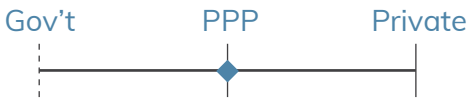
D. Development of mobile application
Develop a user-friendly, multi-lingual mobile application (potentially in English and Mandarin first) to combine all services and functions together as a one-stop platform and provide incentives for tourists to download as soon as they arrive Phuket, for instance free Wi-Fi or taxi credits

E. System integration to enable ride hailing and emergency alert functions
Install applications for taxi drivers to connect them to application users as well as set up a terminal for emergency respond units to get connected with the application users

F. KPIs setup for concessionaire and service launch
Set KPIs for the concessionaire, e.g., tourist satisfaction, number of severe accidents, etc., in order to motivate the concessionaire and assess whether the contract should be renewed in the next round of concession

Timeline

Suggested investment model



Smart Tourism – Smart Immigration

Another potential service initiative is the upgrading of current immigration process at the airport, leveraging smart solutions to achieve Smart Immigration. The service has been recognized for its success as it is able to facilitate more tourists through the immigration process in a given time period while maintaining high security standard. Below is the service overview and issues expected to be addressed by the solution.

Service overview

Functions

Upgrade of current immigration process at the airport by implementing passport scanners and automated immigration barriers to reduce delay as well as labor resources required, AI-based facial recognition cameras and biometric scanners to enhance security standard, and finally online document storage system to encourage the conversion of paper-based record keeping into electronic documents to be stored in central hard drive that can be easily tracked and traced.

Benefits to key stakeholders

Tourists – Faster immigration process leading to better arrival experience
Phuket Immigration Bureau – Systematic and electronic record keeping, allowing better tracking and tracing of data and reduced load on immigration staffs and congestion at the airport
Tourist Police Bureau – Better security measures allowing better identification of criminals and better security database

Required infrastructure/ component

Automated immigration barrier – Physical barrier, equipped with passport scanner for faster flow of immigration process
AI-based facial recognition camera – Facial recognition camera, equipped at the immigration checkpoint, to scan for criminals and keep track of individuals entering the country
Biometric scanner – Fingerprint scanner to provide double-layer security against criminals, as well as for record keeping
Online document storage system – Record keeping system to ensure all documents are kept in electronic format

Issues/ situation in Phuket

Current issues & situation in Phuket

Phuket is increasingly experiencing higher numbers of visitors landing from international flights. This means the immigration bureau will have to prepare for larger crowds and heavier peak hours. As a result, the ability to process visitors through the immigration process as quickly as possible, yet maintaining high security standard, is therefore a desirable goal. There are also many reports from visitors that they have experienced longer immigration processing time. Therefore improving the processing time will in turn improve the overall travelling experience. Finally, many of the record keeping are still conducted on paper, therefore it is advisable to transform this into electronic records for safekeeping and easier sharing.

"Sometimes I land directly in Phuket and have to wait for some time at the immigration since immigration queues in Thailand are generally very long. " – Tourist in Phuket

"Most record keeping and documentation are still heavily paper-based which makes it difficult to share statistics with other government agencies who may benefit from the information" – Municipality officer

Smart Value Chain

We have developed value chain for Smart Immigration initiative. This value chain will allow the existing service operator to understand the required key actions for both service set up and operations

Service set up & development		Smart service operations	
Procurement of equipment	Installation of equipment and system	Operation of equipment and system	Maintenance of equipment and system
			
> Equipment provider	> Equipment provider	> Phuket Immigration Bureau	> Equipment provider

xxx = Public agencies

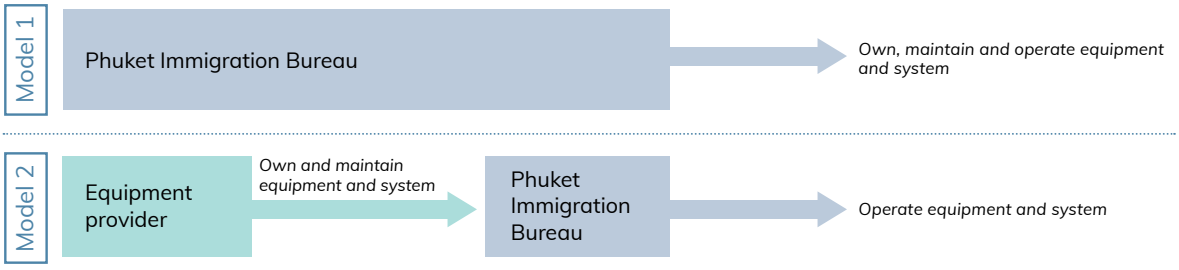
Service operator role assessment

Based on the observed international case studies, Smart Immigration is normally operated by the immigration bureau, with support from the airport authority. Even though the immigration process will have to be facilitated by agents of the immigration bureau, the maintenance and ownership of the equipment may be sub-let to a private company under a contract. We have conducted the assessment to understand pros and cons of each operator type.

	Description	Pros	Cons
Phuket Immigration Bureau	> Conduct all operational activities including including the maintenance of equipment/ system	> Complete control and ownership of assets	> Maintenance will have to be done by technicians, leading to further upfront investment which may result in the leftover of depreciated assets after a certain period of time
Equipment provider	> Owns and handle only maintenance of equipment/ system, leaving out the responsibility on operation activities with Phuket Immigration Bureau	> All assets are outsourced, and can therefore be replaced after end of contract	> Incurring payment required by the appointed private company

Business model options

In this section, we will discuss two business model options for this service initiative. Considering the pros and cons of each model, the model of choice would be the second model, where a private party is appointed to procure the necessary equipment, set up the system as well as overlook the maintenance process. This is so that Phuket Immigration Bureau will not have to invest in equipment and conduct their own maintenance. As the private company will likely be selected via a bidding process, the incurring fees are likely to be competitive, which should be beneficial to Phuket Immigration Bureau. Since agents of Phuket Immigration Bureau will be facilitating the immigration process, the private company will have minimal interference with the actual immigration process.



Action plans

A. Selection of private party
Launch a TOR to find the most suitable private party with ample experience and good track record in the field, who will operate and maintain the equipment and network

B. Agreement of contract/ leasing terms
Agree with the selected private company the terms of the leasing contract, i.e., duration of contract, fee payable and maintenance frequency

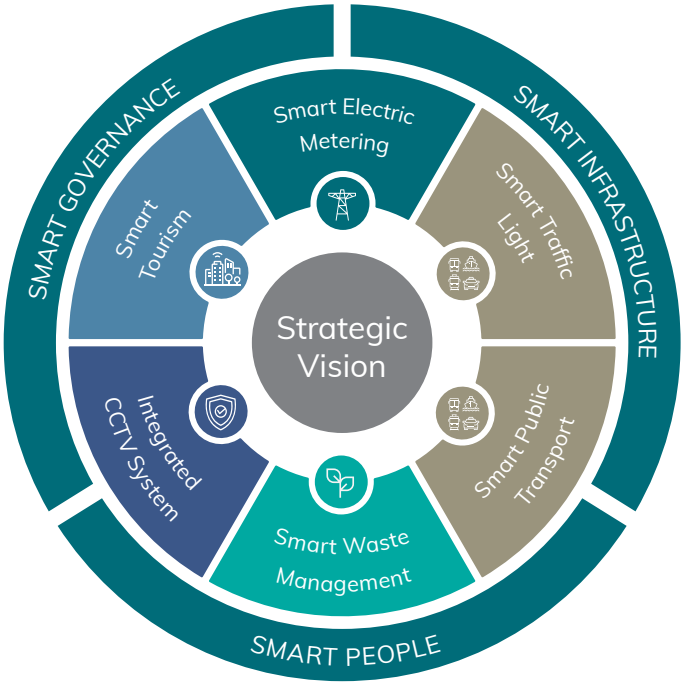
C. Installation of new equipment and system
Work with the private company in replacing old immigration process with the new equipment and system to ensure seamless transition with minimal disruption to daily operations

D. Training of immigration bureau agents to use new equipment and system
Train current immigration agents on how to use new equipment and system, as well as the primary troubleshooting protocol

Timeline

Suggested investment model

CONCLUSION OF THE STUDY



Phuket is a unique city, being one of the fastest growing in terms of urbanization and number of visitors despite it's small size. However, with the rapid growth comes various obstacles which Phuket has to face. Being Thailand's 2nd largest tourist destination, the number of visitors and migrants who have come to work in Phuket outgrew the number of locals, leaving the province unable to deal with the massive production of waste, high demand in electricity, and extremely congested roads, to name a few issues. These are some of the key drivers pushing for the adoption of smart city technologies, to help ease the issues and maintain Phuket as a competitive tourist destination within the region.

With growing number of obstacles to deal with but limited resource allocated, Phuket is turning to smart city to efficiently manage resource in order to generate as much value as possible. Examples of some smart city initiatives being carried out in Phuket are smart waste management, smart bus and city data analytics; giving Phuket a head start in comparison to other smart cities in the country. However, there are still gaps to fill and issues to tackle, which is why through international case studies, expert consultation and local stakeholder engagement, this report attempted to shortlist and prioritize smart city services to recommend for Phuket.

Using a systematic scoring matrix, combined with insights and pain points identified from stakeholder interviews, 6 smart city verticals have been shortlisted as priority for Phuket, including Smart Public Transport, Smart Traffic Light, Smart Electric Metering, Smart Waste Management, Smart Tourism and Integrated CCTV. These prioritized services are recommended to tackle Phuket's immediate and major pain points, for instance, Smart Public Transport and Smart Traffic Light will open up more options for visitors to commute within Phuket and at the same time, ease the congestion on roads in the city area. Smart Electric Metering will allow local authorities to prepare for and respond to blackouts from power surges. Smart Waste Management will efficiently deal with excess waste with the allocated resource. Smart Tourism and Integrated CCTV will ensure a smooth, safe and worry-free experience in Phuket for visitors and locals alike.

Moving forward, none of these initiatives would be possible without the collaboration of stakeholders, both public and private. Observed from international best practices, private parties would often pioneer the technology and operate the smart city services as efficiently as they can, whilst the public sector would provide the necessary infrastructure and regulatory support, drawing the strengths from both sides. Together, both parties can bring Phuket to the next level of smart city and set examples for other provinces in Thailand.

SMART CITY FRAMEWORK AND GUIDANCE FOR THAILAND

Smart City services for Phuket

White Paper
August 2019

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