Infrastructure Asset Management for Developing Countries to Achieve the SDGs

Case Studies

Authors: Soraya Azhar, Yubing Chen, Alan Feng, Shelly Sun, Luis Trevino, Trang Vu
Faculty Advisor: Isabelle Delalex

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School of International and Public Affairs

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Abstract

This research project is proposed by the Financing for Sustainable Development Office (FSDO) in the Department of Economic and Social Affairs in the UN Secretariat, following the release of its handbook, “Managing Infrastructure Assets for Sustainable Development: A Handbook for Local and National Governments.”

The following research produced case studies illustrating good practices in "infrastructure asset management for sustainable development" in the following countries:

- China: Oriental Beauty Valley (industrial infrastructure development), Medical Community (integrated public healthcare infrastructure) and Shanghai History Museum
- Malaysia: Stormwater Management and Road Tunnel (SMART Tunnel)
- Vietnam: North-South Expressway (high speed train line)
- Mexico: System for Ecological Management and Waste Processing (SIMEPRODE)

The case studies apply the handbook’s asset management tools in analyzing how robust environments meet their purpose and goals and highlighting the relationships with robust Life Cycle Management, Demand Management, and Financial Management while achieving the UN Sustainable Development Goals (SDGs). They will be appended in the UNDESA handbook on infrastructure asset management.

Introduction

This Capstone project researches case studies that can be appended in the UN DESA handbook on infrastructure asset management published in early 2021, preceding the release of the UN DESA's massive open online course (MOOC), on the same subject, scheduled for release later in 2021. Thus, each of the case studies integrates the handbook's asset management tools in highlighting the UN SDGs and the impact of Life Cycle Management, Demand Management, and Financial Management on the management of infrastructure assets. The case studies highlight good management practices in strengthening communities and resilience in times of crisis, such as climate change and pandemics.

The case studies selected to underline good practices in "Infrastructure Asset Management for Sustainable Development" focus on projects in China, Malaysia, Mexico, and Vietnam. The assessment of good practices in infrastructure asset management relies on the Asset Management Action Plan in Chapter Three of UN DESA's Handbook. The main research methodology captures the information gathered following field interviews with local technical officials managing the infrastructure assets. Some of the questions answered by focal points interviewed include: how does the government and asset managers incorporate principles of sustainability (economic, social and environmental factors), procure funding for the operation and maintenance, and manage risks from climate and COVID-19 pandemic shocks in managing its assets.

The following is a brief description of the case studies with relevance to UN SDGs:

1. Malaysia's Stormwater Management and Road Tunnel (SMART Tunnel): The dual-purpose tunnel in Kuala Lumpur City is built to mitigate flood and manage traffic congestion, contributing towards the achievement of UN SDG 6: Clean Water and Sanitation, SDG 9: Industry, Innovation and Infrastructure, SDG 13: Climate action, and SDG 17: Partnerships for the Goals. The scope of research in this case study involves principles and procedures for the management of the asset to ensure its robustness, sustainability, and accessibility to mitigate flooding in the city centre.

2. Shanghai Oriental Beauty Valley (industrial infrastructure development) in China: This is an urban industrial ecosystem that promotes beauty and healthcare industries while integrating them to the urban and cultural development of the Fengxian District in the city of Shanghai. This development contributes towards the achievement of UN SDG 9: Industry, Innovation and Infrastructure, SDG 11: Sustainable Cities and Communities, and SDG 17: Partnerships for the Goals. The research lies primarily on the principles of good practice in operations management with an emphasis on financial management and incentives to engage affiliated enterprises.

3. China's Medical Community (integrated public healthcare infrastructure): The Medical Community framework, an important government initiative adopted in 2017, aims to

achieve efficient use of resources by facilitating collaboration between hospitals especially in containing the COVID-19 pandemic. It meets UN SDG 3: Good Health and Well-Being and focuses on the capacity and operations of medical facilities to deliver the optimal level of medical services.

4. Shanghai History Museum: This development is designed to provide community services and preserve its historical and cultural heritage. The museum mission is aligned with the achievement of the UN SDG 4: Quality Education, SDG 11: Sustainable Cities and Communities and SDG 12: Responsible Consumption and Production are incorporated in this case study. The main focus of our research is to explore the impact of the museum management practices as they pertain to the repurposing of the museum and community engagement. The case study also emphasizes the museum's operations and use of technologies and innovation in preserving cultural and historical legacy.

5. Vietnam's North-South Expressway (high speed train line): This national flagship project was selected to illustrate a transportation infrastructure that could withstand climate shocks in coastal regions. The project is aligned with the goals of UN SDG 8: Decent Work and Economic Growth, SDG 10: Reduced Inequalities, SDG 13: Climate Action, and SDG 17: Partnerships for the Goals. The scope of this case study explores the principles and procedures that foster a robust maintenance, operation, sustainability, and accessibility of the asset.

6. Mexico's System for Ecological Management and Waste Processing (SIMEPRODE): This integrated solid waste system and bioenergy plant generates energy for 80% of the public lighting and the inner-city railway system. The case study highlights the development alignment with UN SDG 7: Affordable and Clean Energy and SDG 11: Sustainable Cities and Communities. The research highlights good practices of financial management, particularly those dealing with the use of carbon credits and favorable local tax regimes. Particular attention is given to the aspects of the public-private partnership enabling the financing of the operation, its maintenance, and the long-term expansion of the State's waste management system and independent electric generation system capacity.

Case Study 1: Malaysia's Stormwater Management and Road Tunnel (SMART Tunnel)

Background

This case study highlights good practices in the management of an infrastructure asset that mitigates flooding and reduces traffic congestion in a metropolitan area. The Stormwater Management and Road Tunnel (SMART Tunnel) in Kuala Lumpur city in Malaysia was selected as an example of a good flood mitigation system that addresses the high risks of flash floods in a metropolitan area. The SMART Tunnel exemplifies the management of an infrastructure asset that is aligned with the goals of UN SDG 6 on Clean Water and Sanitation, SDG 9 on Industry, Innovation and Infrastructure, SDG 13 on Climate Action and SDG 17 on Partnership for the Goals. The framework of analysis of the case study outlines the life cycle, demand and financial management of the SMART Tunnel based on information shared during a video interview with Malaysia's Department of Irrigation and Drainage on February 18, 2021.

Life Cycle Management

a. Plan and Acquire

The Department of Irrigation and Drainage under the Ministry of Water and Environment, and the Malaysian Highway Authority entered into a public-private partnership with MMC Corp Berhad and Gamuda Berhad, to build an integrated flood mitigation and road tunnel in the Kuala Lumpur City Centre (SMART Tunnel, n.d.). The construction of the tunnel over four and a half years costs RM1.933 billion (about USD525 million) and began its operation on 30 June 2007. This tunnel is named the Stormwater Management and Road Tunnel (SMART Tunnel) and is an underground tunnel that spans 9.7 kilometres in length and 11.8 metres in diameter. The SMART Tunnel is a public infrastructure asset owned by the Department of Irrigation and Drainage and managed by the SMART Tunnel Control Centre under the department.

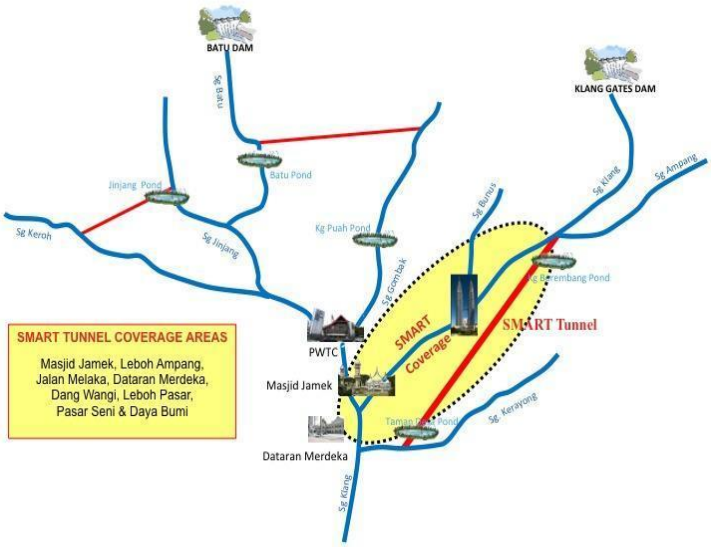

Figure 1. SMART Tunnel Coverage Area.
Source: SMART Tunnel.

The main purpose of the tunnel is to mitigate flooding in the city centre after studies identified that the surrounding areas near the confluence of Klang and Gombak rivers in the city centre were highly prone to flash floods, especially during the Monsoon season (November to March). Prior

to the SMART Tunnel initiative, major flash floods in the city centre occurred in 1926, 1949, 1971, 2001, 2003, and 2007. Since its operation, the tunnel is estimated to have saved the city from significant cost of damages to public and private assets in the city centre amounting to RM100.8 million (approximately USD 24 million) per year or RM1.411 billion (approximately USD337 million) over 14 years. The SMART Tunnel prevented 15 hectares of area in the city centre, or the equivalent to 20 football fields, from being underwater during the flash floods in September 2020 (Babulal and Teoh, 2020). Notably, the road tunnel in the middle and upper decks can be used as an alternative highway to reduce traffic congestion entering and exiting the city centre during peak hours.

b. Use

The SMART Tunnel system reduces flooding by diverting up to 3 million cubic metres of floodwater from the upper catchment areas near the confluence of the Klang and Ampang rivers to the Kerayong river. The tunnel has three decks which are used to divert flood water based on four modes.

- **Mode 1:** No water is diverted into the tunnel.
- **Mode 2:** Activated when rainfall is moderate and the water flow rate at the confluence of upper Klang and Ampang rivers is between 70- and 150-meter cube per second. The lowest deck is used for flood water diversion.
- **Mode 3:** During a major storm event where the upper confluence of Klang and Ampang river flow rate reaches 150-meter cube per second, water is diverted in the lowest section of the tunnel. The road tunnel is closed from traffic.
- **Mode 4:** Activated when heavy storms prolong for 1 to 2 hours after Mode 3 is activated. Water will flow through all 3 decks of the tunnel.

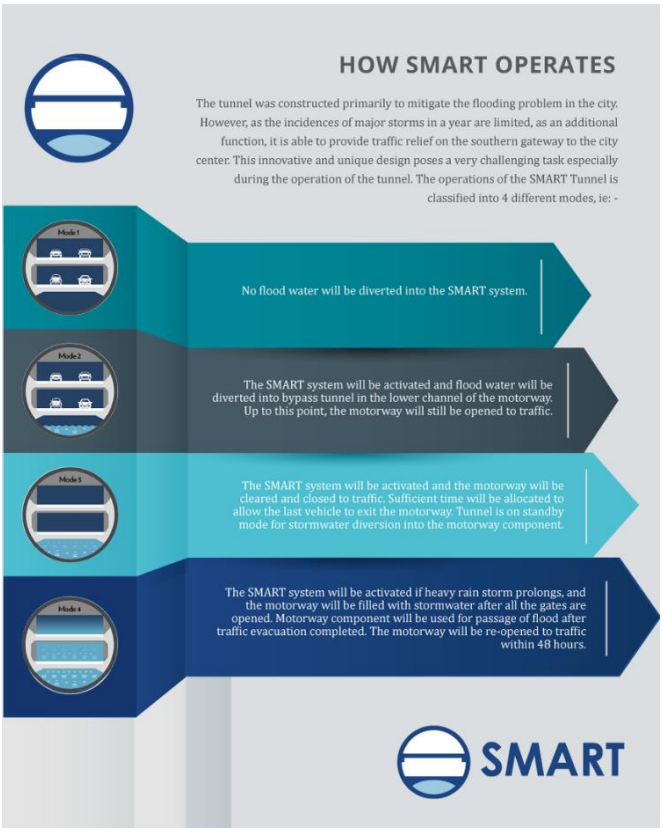

Figure 2. SMART Tunnel Operational Modes.
Source: SMART Tunnel

The SMART Tunnel system has been activated 480 times in the past 14 years with Mode 2 at 379 times, Mode 3 at 94 times and Mode 4 at 7 times.

To avoid redundancy of the tunnel when only the lowest section of the tunnel is used to divert flood water, 3 kilometres of the tunnel were built into 3 decks for light vehicle traffic on the upper and middle decks. The motorway tunnel eases traffic congestion in the city by providing an

alternative route for traffic users and reduces travel time from fifteen to four minutes compared to existing roads. The motorway tunnel is utilized by about 30,000 vehicles a day (Marsh McLennan, n.d.). It closes for traffic in Modes 3 and 4 and re-opens in at least 4 days since closure after the tunnel is cleaned and repaired from flood debris and wastes.

c. Maintain

The Department of Irrigation and Drainage regularly maintains and repairs the SMART tunnel, 30 hydrological stations, floodgates, Flood Detection System, holding pond and attenuation pond to ensure that it is at an optimal level. Routine inspections on the systems and tunnel are conducted on a weekly, monthly, and quarterly basis according to the department's maintenance schedule. These maintenance measures are conducted based on the department's Preventive and Corrective Maintenance Schedule. For example, emergency repairs are completed within 1 hour while wear and tear repairs are completed within 14 days. There are engineers on standby for 24 hours, 7 days a week to ensure that the system is at an optimal level. The department also replaces its mechanical and electrical spare parts annually. The SMART Tunnel Control Centre has been certified as compliant to its standard operating procedures and best practices by its internal audit and external auditors – the Standard and Industrial Research Institute of Malaysia (SIRIM), and the International Organization for Standardization (ISO). The SMART Tunnel is also inspected by external electrical engineers four times a month as required in the Electricity Regulations 1994 (Energy Commission, 1994).

d. Dispose

The tunnel is expected to continue to be functional in the foreseeable future. Thus, there are no plans to dispose of any of the infrastructure assets. The focus is on regular inspection of the software and hardware to identify requirements for maintenance or replacement.

Demand Management

The Department of Irrigation and Drainage engages external consultants to conduct Flood Damage Assessment throughout the whole country every 5 years, guided by the Guideline and Procedures for the Assessment of Flood Damage in Malaysia published in 2003. The guideline was first developed by the Japan International Cooperation Agency (JICA) in 1982 and further updated by the Department of Irrigation and Drainage in 2003 based on practices in the United States, the United Kingdom, Japan, New Zealand, and Australia (Department of Irrigation and Drainage, 2003). The assessment also includes identification of future changes in river flow rates due to pollution and climate change.

Since 2009, the Department of Irrigation and Drainage has developed Flood Hazard Maps, Flood Damage Maps, and Flood Risk Maps in every State of Malaysia (Department of Irrigation and Drainage, 2020). The maps define the potential spread and depth of floods in cities and towns along the rivers. This is done through estimation of the potential direct (properties, infrastructure assets, and motor vehicles) and indirect (clean-up costs, travel disruptions, and loss of income/wages) damages arising from flood events (Department of Irrigation and Drainage, 2003).

The Flood Hazard, Damage and Risk Maps provide valuable data to support economic rationale for flood mitigation projects, helps to prioritise projects at the National and State levels, and prepares local governments for future flood events (Department of Irrigation and Drainage, 2003).

The SMART Tunnel Control Centre follows a strict standard operating procedure to activate Modes 2 to 4 through 24-hour monitoring of river flow rate and rainfall using a real time flood detection and automated management system called the Supervisory Data Acquisition and Control (SCADA). SCADA relies on 28 remote monitoring stations to guide decisions on 31 water gates, seven water pumps, and four independent generator setups along the system (WaterWorld, 2008). In case of system failure, the tunnel systems have various backups to alert on high river flow rate and rainfall via radio and messaging systems that are sent by technicians stationed at the hydrological stations. This active monitoring process has successfully prevented the overflow of Klang and Ampang rivers since the tunnel operation.

The SMART Tunnel operations is considered as an essential sector since it performs public service. The monitoring and activation of Modes 2 to 4 require the presence of the department's officers at the SMART Tunnel Control Centre. During the lockdowns imposed by the Malaysian government due to rising COVID-19 cases in 2020 and 2021, employees and businesses in essential sectors were allowed to operate onsite. Thus, all officers responsible for the operation of the SMART Tunnel were required to continue working at the SMART Tunnel Control Centre during the lockdowns while strictly complying to mask-wearing and social distancing rules by the government.

The main challenge of the SMART Tunnel management is the timely activation of the Modes 2, 3 and 4 to prevent flooding. This depends on the speed and accuracy of hydrological data received by the Flood Detection System. The Flood Detection System provides advance warning to prepare for Modes 2 to 4. This requires regular updating of the Flood Detection System to incorporate the latest technology development. The department also monitors the rainfall, water level, and water velocity data at the upper catchment area. This is important to ensure that the motorway tunnel is promptly closed to traffic and fully utilised for flood water diversion.

Another challenge identified in the operation of the SMART Tunnel is the cleaning of rubbish and sediments from rivers that clog up the water pumps and floodgates. The Department of Irrigation and Drainage spends RM48,000 (approximately USD11,500) per year to clean an average of 78.6 metric tonnes of rubbish per month from the Klang and Ampang rivers. The Klang river is one of the most polluted rivers in Malaysia and one of the top 50 most polluted rivers in the world (Plastic Smart Cities, n.d.). Besides poor drainage and climate change that brings about heavier rainfall, river pollution is also one of the main causes of flooding in the city. There are continuous efforts to clean the rivers including the River of Life project which cleans and beautifies 8 rivers covering 110 kilometres that passes through the Kuala Lumpur city centre (River of Life, n.d.). The River of Life project not only significantly cleans the Klang river of pollutants, but it also transforms it into a vibrant and liveable waterfront in the Kuala Lumpur city centre. In addition, the Department of Irrigation and Drainage conducts various public outreach programmes to improve attitudes and behaviours of local communities to reduce river pollution.

To encourage sustainable practices among asset managers in the Department of Irrigation and Drainage, a 'Goes Green' sustainability competition is held annually. The SMART Tunnel Control Centre won the 'Goes Green' sustainability competition in 2018. The Department of Irrigation and Drainage strives to improve its sustainability efforts by encouraging suggestions from its staff and collaborating with local universities to find viable sustainable solutions. The SMART Tunnel Control Centre uses solar energy to generate electricity and LED lighting. It is also taking steps to achieve a 5-star green building award.

Financial Management

The construction of the SMART Tunnel from 2003 to 2007 which costs RM1.93 billion (approximately USD525 million) was jointly funded through a public/private partnership arrangement between the Malaysian government and two private construction companies, MMC Corp Berhad and Gamuda Berhad. The added motorway tunnel that is funded and operated by a Joint Venture company of MMC Corp Berhad and Gamuda Berhad reduced the government's financing by two-thirds of the project cost (SMART Tunnel, n.d.).

In terms of funding for the operation and maintenance of the SMART Tunnel's flood mitigation systems, the Department of Irrigation and Drainage prepares an annual financial budget based on projected operations and maintenance costs. The projected costs are based on projections of flood occurrence that requires the activation of the SMART Tunnel for flood diversion. The budget requires the approval of the Ministry of Water and Environment and subsequently the Ministry of Finance before the start of the financial year. At the end of the year 2020, the Ministry of Water and Environment approved the budget of RM6 million (approximately USD1.45 million) for tunnel operation and maintenance procedures throughout 2021. So far, the department has not faced any challenges or objections in obtaining approval for the proposed budget. Requests for an additional budget requires the approval of the Malaysian Economic Planning Unit, under the Prime Minister's Department, through the Ministry of Water and Environment.

The cost for the operation and maintenance of the motorway tunnel is borne by the SMART motorway control centre, which is a Joint Venture company between MMC Corp Berhad and Gamuda Berhad. Part of the costs are subsidised through the collection of toll fees of about USD0.70 per entry from the road tunnel traffic users.

Case Study 2: Shanghai Oriental Beauty Valley

Background

This case study aims to identify good practices in the operations and maintenance of the Oriental Beauty Valley industrial park in Shanghai, China. The study highlights the strategic incentives and land management to advance China's beauty and healthcare industry in the Fengxian District of Shanghai. It integrates the UN SDG 9 on Industry, Innovation, and Infrastructure, SDG 11 on Sustainable Cities and Communities and SDG 17 on Partnerships for the Goals.

Figure 3. Oriental Beauty Valley in Shanghai, China

Life Cycle Management

a. Plan and Acquire

Established in 2015, The Oriental Beauty Valley is an industrial park and system in the district of Fengxian located in the Southern part of Shanghai. It takes the form of a physical land, and a multilateral industrial system that serves to extend the value chain and create a multi-level business system across Shanghai mainly within the beauty and healthcare industry. The three-dimensional level of the industrial system consists of three axes that aim to integrate sustainability in management: product axis, service axis and industry axis. The product axis includes the Research and Development (R&D), manufacturing, packaging and sales. The service axis includes raw material procurement, Original Design Manufacturer (ODM), Original Equipment Manufacturer (OEM) production, inspection and testing, marketing, brand promotion and other supporting functions. The industrial axis includes product display, user experience, beauty care, medical care, trade, and interactive consultation.

The Oriental Beauty Valley integrates industries including tourism, leisure, e-commerce, sports, financial services, fashion industry, and luxury goods, forming a "beauty and healthcare industry alliance". The beauty and healthcare industry is at the core of the system, with other industries operating in symbiosis. Broadly speaking, the Oriental Beauty Valley is an "urban industrial ecosystem," making Fengxian the largest beauty and healthcare hub in China. The number of cosmetics companies located in the Beauty Valley represent more than a quarter (26%) of the cosmetics companies in Shanghai.

b. Use of Core Assets

The Oriental Beauty Valley manages a variety of infrastructure assets ranging from transportation to ecological facilities. Assets are managed by the Fengxian District Committee, the District Government, relevant territorial divisions and state-owned enterprises.

Major transportation infrastructures such as the southern extension of Subway Line 5, the Hongmei South Road Cross-River Tunnel, the city's first Bus Rapid Transit, and the Minpu Bridge are open to traffic and managed by the Valley.

Urban functional projects such as Shanghai Fish City Living Room, Jiukeshu Future Art Center, Urban Planning Exhibition Hall, Museum, and University for the Elderly are open to the public. A number of high-quality medical resources such as Xinhua Hospital, National Women's and Children's Department, Fudan Pediatrics have also settled in the industrial park. A 22-kilometer shoreline public space of Shizishui Street is also a landmark operated within the industrial park. Flower of the Sea Civic Activity Center, Longhu Skybridge, R&F Wanda Plaza and other projects are currently under construction. The Beauty Valley also owns several office buildings throughout the city of Shanghai.

Environmental facilities such as a national garden and river town are also part of the industrial park. The industrial park also owns 571 hectares of green field and 2,127 hectares of forest field.

c. Stakeholders and Management

The Shanghai Municipal Party Committee and Municipal Government provided support to the Fengxian District in gathering endowment funds for the construction of the industrial hub. The Oriental Beauty Valley Industry Promotion Office, the Oriental Beauty Valley Industry Promotion Center, and the Oriental Beauty Valley Enterprise Group Co., Ltd. were created to implement a system of effective cooperation between the government, associations, and enterprises.

The Oriental Beauty Valley Industrial Promotion office plays a key role in leading the development direction, coordinating the relevant functional departments and territorial units in the region and ensuring smooth facilitation of various tasks in construction.

The Oriental Beauty Valley Enterprise Group Co., Ltd. acts as the brand holder of the Beauty Valley. It focuses on brand marketing, brand registration and trademark licensing.

The Oriental Beauty Valley Industry Promotion Center promotes commercial links for enterprises in the beauty and healthcare industry by encouraging opportunity sharing and cross-border cooperation.

d. Management Over Outsourced Assets

The Oriental Beauty Valley exercises control over outsourced asset management services by integrating technology and management. Methods include standardizing online services,

optimizing online service procedures, promoting online handling of service matters, innovating online service models, and providing full disclosure of service information.

The Oriental Beauty Valley actively communicates with the division of administrative inspection and approval functions of the municipal and district governments while focusing on simplification of administration and delegation of powers to optimize the administrative inspection and approval processing time. It uses a comprehensive supervision platform to strengthen information sharing, improve cross-departmental supervision and coordination, prevent and control safety risks and ensure sustainable growth of the industrial system.

Demand Management

A main policy in the Oriental Beauty Valley's asset management is to establish a coordinated mechanism between the city and the district. The Fengxian District founded the Beauty & Health Industry Promotion Group with the motive to let it lead industrial planning, project promotion and establish good practices in the development and service environment. For city level affairs, the relevant city departments take the lead in convening meetings, conducting research, and coordinating different parties to ensure smooth communication between stakeholders.

In terms of managing the enterprises within the industrial park, the Oriental Beauty Valley manages those in their operational level to ensure good corporate development practices. This includes ways such as ensuring high employee satisfaction and collaborative business environments within enterprises. The Oriental Beauty Valley provides various types of services including basic property maintenance, commercial services, professional corporate services, and community operations.

In addition, the Oriental Beauty Valley utilizes a traceability management cloud platform and a smart supervision platform. The platforms divide the enterprises in the Oriental Beauty Valley into four major industries: cosmetics and beauty, medicine and health, fast-moving consumer goods and others. The Oriental Beauty Valley utilizes the platforms to supervise these industries according to their industry characteristics at the same level. It also enforces its own regulatory measures to govern and manage corporate members in regional brands, coordinate business practices within the same industry, and supervise quality of products and services, thereby improving the monitoring of the beauty and health industry's performance statistics and producing value-added consulting services for affiliated enterprises.

a. Principles of Sustainability in Demand Management

Sustainability of the industrial park takes into consideration the economic, social and environmental pillars. In each aspect, the industrial park sets a few objectives for its regional brands.

The economic aspect consists of four factors. The first is to integrate. Regional brands have the ability to attract a large number of enterprises, technical talents and suppliers in a short period of time because of their unique industrial cluster effect, which provides the foundation of

development of the regional economy. The second is to increase core industry value. Regional brands play a role in promoting the sales performance and boosting value for their core industry. The third is to use regional branding as an indicator of innovation. The industrial park serves as a network for industries and brands to collaborate and benefit from each other's expertise. The fourth is to encourage regional economic competitiveness in order to optimize the allocation of resources, which will promote regional economic development.

The social aspect of objectives consists of three factors. The first is to increase local income levels by promoting developments of related industries through regional brands. This would ultimately stimulate local economic activity. The second is to create a stable employment level by creating new market players and high-quality jobs, which would drive local individuals to return to their hometown for employment. The third is to improve social living standards. This includes improving the basic supporting facilities in healthcare, education, culture, sports, and commercial services to meet the demands of the local residents.

The environmental aspect is divided into two factors. The first is supervision. Some methods for supervision include setting long-term plans for environmental protection in the region, formulating effective mechanisms and policies to deal with potential environmental issues, providing online platforms to assist affiliated enterprises in responding to environmental emergencies, carrying out real-time assessments of the environment in the region, supervising enterprises and formulating reward and penalty measures to ensure that enterprises emphasize environmental protection. The second objective is taking social responsibility to increase the green level in the region and beautify the ecological environment in the region. This consists of actively reducing pollution in the surrounding environment and maintaining a good environment in the entire region.

Financial Management

The Oriental Beauty Valley aims to enter capital markets in the near future for the purpose of raising funds for future expenditure and asset-related costs. By capitalizing on the opportunity provided by the Science and Technology Innovation Board, the Oriental Beauty Valley aims to promote economic transformation and enterprise development. Its participation in the capital market will likely pave the way for high-quality affiliated companies looking to hold initial public offerings and support enterprises in mergers and acquisitions focusing on high-end technology, talents and brands. It will also leverage top-tier technology, management teams, business models, marketing channels and other resources to form a group of high-tech and high-quality enterprises.

To prevent foreign investment risks, the Oriental Beauty Valley aims to direct some of its capital to 1) provide expert guidance on mergers and acquisitions, 2) promote industrialization of scientific and technological achievements with a market-oriented and international capital operation model and 3) promote the use of capital for innovation, entrepreneurship and liberalization of industrialization and achievements in science and technology.

a. Incentives

Tax policies are under the unified control of the state. The government provides industrial support and financial reward for enterprises within the Oriental Beauty Valley that meet the requirements of Shanghai's major healthcare industry.

Enterprises that receive industrial support and financial incentives are expected to meet several conditions such as those that 1) focus on the beauty and healthcare industry while actively participating in projects and platforms in advanced manufacturing, innovative service, and strategic emerging industries and 2) emphasize integrating the headquarters of the enterprise in the district's spatial layout. The key construction land indicators for major projects in the beauty and healthcare industry can be coordinated and supported by the city with approval from the city's "three committees and two bureaus." Flexible transfer of industrial land can be granted to enterprises that meet the requirements. Industrial project zoned land is first transferred for a 20-year period. After the 20-year period, if the project still aligns with the goals of the Oriental Beauty Valley, the contract can be renewed for 30 years at the original transfer price. This totals to 50 years, which is equivalent to the 50-year land contract limit for major strategic industrial and functional projects in Shanghai.

Tax policies are uniformly controlled by the state. The benefits of industrial support and financial incentives given by the government to the enterprises in the Oriental Beauty Valley are mainly reflected in consolidation and upgrade in the energy level of the real economy, cultivation of new growth drivers, optimization of market supply, improvement in quality of life and promotion of Shanghai as an international 'city of design, trend and brand.'

The main opportunity cost of tax benefit for the Oriental Beauty Valley is the proceeds that can be allocated to develop methods for efficiency in land and resource sharing. There is a rise in negative growth pressure of construction land in the Fengxian District and conflict between strong demand for economic growth and restrictions in size of construction land. There is a low level of revitalization, sharing and utilization of existing industrial resources, and there are only a few innovative methods for resource fragmentation. The result is hindrance to introduction of high-quality projects.

Challenges

As previously mentioned, some challenges in the district and the Oriental Beauty Valley include constraints in spatial development resources and inefficiency in resource sharing. In addition, the environmental protection requirements of industrial development are continuing to strengthen. As a result, industrial access is increasingly restricted by environmental protection. Fierce competition for capital, market, and talent in the biomedical industry against the neighboring region in the Yangtze River Delta is also a challenge faced by the Fengxian District.

The Oriental Beauty Valley aims to overcome these challenges by identifying synergies with existing municipal government policies. All functional departments implement the municipal government's policies for the real economy, beauty and healthcare industry, private economy

development, foreign trade development and advanced manufacturing industry regions. Doing so will lead to an efficient operation and approval period of various functional departments and a timely process of policy implementation.

Another solution is to strengthen various guarantees. This includes increasing financial support to effectively allocate funds at the municipal level, increasing industrial policy support to strengthen land supply security, and exploring innovative measures to increase economic density and pilot flexible management of land use.

An ongoing challenge for some of the affiliated enterprises has been to factor the impact of the current pandemic into the production and operations. As processing speed for trade declined, the transportation prices also skyrocketed to approximately nine times the regular price. The pandemic also affected foreign investment in 2020 as foreign investors and market participants were unable to travel to Shanghai for major roadshows and events such as the Oriental Beauty Valley Expo.

Case Study 3: “Medical Community” in China

Background

This case study provides an example of an infrastructure asset management that achieves the UN SDG 3 on Good Health and Well-Being. The “Medical Community” project is a central government initiative in which main public (state) hospitals are responsible for the operations and management of the medical facilities within the area, and mandated to collaborate with lower tier hospitals within the “Medical Community” to integrate medical resources from one region in township, secondary and tertiary hospitals.

Life Cycle Management

a. Plan

The concept of the "Medical Community" project was established to scale up equal access and delivery of quality health services containing the COVID-19 pandemic, and overcome Chinese citizen’s distrust towards small hospitals' ability to provide high-quality care. As a result, due to their distrust in small hospitals, many Chinese citizens travel long distances to seek care in larger city hospitals even for relatively simple testing and procedures. In response to this problem, the Chinese government regrouped and organized medical facilities at the regional and sub-regional levels, which led to the creation of "medical communities". This grouping is designed to achieve a more efficient use of resources, to strengthen township hospitals' capabilities and to facilitate collaboration within the different hospital levels.

b. Acquire

Main public hospitals accept the responsibility to manage a “medical community” for two reasons: 1) they hope to increase their impact in the region and 2) they have a sense of social responsibility and hope to improve the overall level of care delivered while improving their reputation.

c. Use

The Zhejiang Province started the "Medical Community" pilot project in 2017. Currently, 70 cities in the province have formed 161 "Medical Communities" with 208 state hospitals and 1,063 township hospitals.

At the onset of the pandemic, the "Medical Community" fostered trust and demonstrated efficiency at the level of the township hospitals. During this period, Zhujiang Hospital, a state hospital, and its 20 medical branches within one medical community collaborated closely to contain the pandemic. The branches were responsible for the preliminary screening of a large number of cases. Once the patient was diagnosed with COVID-19, a dedicated ambulance transferred the patient to the main hospital for isolation and treatment. When the state hospital did not have enough beds,

the township hospital provided a large number of isolation wards. Similarly, when the main hospital was short of human resources, the branches deployed their medical staff to the main hospital to provide additional support. The community's hierarchical diagnosis and treatment was enhanced by the combined planning of medical resources and mutual assistance. As a result, the State successfully controlled the spread of the disease by early March 2020.

During the pandemic, reducing outpatient visits and avoiding cross-infection was an essential pandemic control measure. The leading (state) hospitals in the medical community opened limited outpatient visits through the "Cloud Hospital", a management system which screens patients through online video consultations. To decentralize the dispensing of medications, the leading hospital signed agreements with more than 600 pharmacies in Zhejiang Province. Patients were able to directly purchase medication at the pharmacy of their choice with their medical insurance card.

In addition, Zhujiang Hospital established a telemedicine platform and conducted remote meetings and training. State hospitals also developed a mobile app called "Each Doctor" which was tailor-made for their own medical communities. Doctors in primary hospitals in the same medical community were able to download the apps to offer remote consultations, upload patient records and communicate with state hospital doctors.

d. Maintain

The Medical Community periodically conducts evaluations on the effectiveness of this initiative. To evaluate the collaboration within the medical community, state hospitals assess the frequency and type of interaction between state and township hospitals. Assessment criteria captures the nature/purpose of the interaction, whether it is a doctor visit, an administration/business guidance meeting or a transferred patient care discussion. To evaluate the degree of collaboration in research and development, the evaluation assesses the scope and scale of the research conducted in primary hospitals. To judge the community's overall performance, the level of research potential on transferred cases and the quantity of two-way patient referrals are taken into account.

Demand Management

During the early stages of the COVID-19 pandemic, hospitals created special units to attend to COVID-19 patients. Enabling other medical departments to operate normally with limited exposure to COVID-19 patients. In addition, fewer non-life-threatening medical consultations were scheduled during the pandemic.

The Chinese government allocated most of its resources along two poles of action to manage the demand for treatment for COVID-19. The first was to standardize the COVID-19 contagion assessment to reach a diagnosis and determine treatment protocols. The second was the streamlining of the deployment process of resources. When the provincial health committees requested human resources support, the demand was met by doctors from many hospitals across the country who volunteered to be deployed (e.g.: Wuhan). More than a dozen experienced nurses who volunteered from the Zhujiang Hospital's Department of Respiratory Medicine and Critical

Care Medicine were deployed to Wuhan (Zhujiang is over 700km away from Wuhan).

The government established a hierarchical/top-down diagnosis and treatments protocol designed to identify the patients that were most seriously ill to receive COVID-19 treatment at primary hospitals. The leading (state) hospitals were tasked to assist the primary hospitals to improve their diagnosis and treatment capabilities to provide care to local residents. If a patient in a specific county visited a large hospital, the lead hospital would recommend him/her to remain in the county for treatment. When a local primary hospital needed validation for their diagnosis or treatments, they would contact doctors from the state hospitals for their remote expert advice (in some cases the expert health practitioner would join the local hospital team). If an appropriate level of care in primary hospitals cannot be offered, patients are transferred to the state hospitals. Once the patient stabilizes, and it is determined that treatment can be adequately provided by the local hospital, the patient is transferred back.

The three stakeholders managing a medical community are: government, state hospital and primary hospital.

Although the government is not directly involved, it supports the medical community project with a "Call-to-action" policy by assigning the state hospital to lead smaller hospitals. There are no repercussions if a state hospital chooses not to participate in the medical community. The government's aim is to achieve more efficient use of the resources and provide easy access to medical care through this initiative.

The state hospitals bear the expenses of the "medical community". Their motivation to lead the medical communities are three-fold. First, state hospitals have a strong incentive to accept this leadership role, there are benefits to anchor their reputation and influence in the region as a specialized hospital. Second, in participating in the "medical community" state hospitals can have access to high-quality medical resources. The high demand for state hospital care, puts pressure on their operations to maintain quality of care. By helping primary hospitals to offer quality care, patients are incentivised to visit their primary hospitals first since they have the capacity to treat common medical conditions. The triage of patients at the primary hospital level is designed to identify the critically ill patients or those patients suffering from difficult to treat conditions that would need to be transferred from primary hospitals to state hospitals to receive the best treatment possible. Another incentive for patients to consult with their primary hospital first, is the use of a "green channel", a referral mechanism enabling primary hospital doctors to refer patients needing highly specialized care, to consult and be hospitalized in state hospitals. Thirdly, the state hospitals also have a sense of social responsibility, hoping to improve primary hospitals' level of care.

In that effort, primary hospitals benefit from state hospital's medical experts for training, teaching, and research. This assists primary hospitals in setting up laboratories, learning management system standards and medical insurance. This framework also helps primary hospitals to achieve higher hospitalization rates and reduce its patient-loss-rate for which they earn more benefits.

There have been instances when state hospital doctors face resistance from established primary hospital doctors unwilling to accept guidance and outside support. The hierarchical management of care within the medical community has fostered in some instances, resistance from the primary

hospital's management or department directors to the initiatives or decisions determined by their state hospital counterparts. One solution may be to improve the communication and information sharing processes between both. Increased data disclosure and greater cooperation between state and primary hospitals would yield further benefits to patients.

The increased hospitalization rate of the medical community's affiliated primary hospitals has yielded a patient-loss-rate decrease; arguably, this metric highlights the good management practices governing the medical community.

Case Study 4: Shanghai History Museum

Background

Originally built as the Shanghai Race Club in 1934, this iconic building, after multiple renovations, now stands as the Shanghai History Museum. Opened in 2018, the museum symbolizes the city's and Shanghai area's political, social, economic and cultural evolution.

Figure 4. Shanghai History Museum

Featured in the museum are archaeological finds, interactive digital displays, maps, dioramas, and recreations of Shanghai's street scenes. The museum also manages other suburban assets such as archaeological sites, ancient relics, and a restaurant called Roof 325 on the 5th floor of the museum.

This case study provides a good example of an asset that aligns with the UN SDG 4 on Quality Education, SDG 11 on Sustainable Cities and Communities and SDG 12 on Responsible Consumption and Production.

Life Cycle Management

a. Plan and Acquire

After this historical building was renovated, the building was repurposed as the Shanghai History Museum. Previously, the Shanghai Art Museum was on this original site, but was moved to a new address. The reason for opening a museum in this location was the belief that once no longer in use, the building would deteriorate quickly. Repurposing the old building could preserve the building, the land and its site which were entrusted to the museum's management team.

The management of the museum is overseen by the Shanghai Municipal Bureau of Culture and Tourism. In 1949, the land and the building belonged to the Race Club; today, the ownership has been transferred to the museum. Exhibits and the building maintenance are managed by the museum, who hires external contractors for operations such as cleaning and equipment maintenance.

b. Use

The museum exhibitions, their themes and the artifacts displayed are all curated independently by

the museum. A dedicated education team produces from existing collections and the public's interests, educational material, that includes the use of multimedia and interactive activities.

Multimedia tools are usually proposed by the curator and realized by a designer. Each pavilion has its unique theme. Since the museum's visitors are mainly Shanghai residents, its exhibition is designed to encourage the public to post photos on their social media accounts to attract visitors. The Shanghai museum is more conservative than other museums with its use of multimedia, however, it features both special exhibition space and online exhibitions.

c. Maintain Through Preservation

There has been a gradual interest in the conservation of architectural cultural heritage. After rapid large-scale urban construction, the Shanghai Municipal Government began to carefully consider preserving architectural cultural heritage; and established both a conservation score and heritage preservation mechanism.

The buildings are protected according to their significance and quality. Various conservation options are used: repair, relocation, expansion, restoration, and re-modelling. These are captured by the motto: "combining use and conservation, and preserving by using".

"Preserving by Using" at Shanghai History Museum

The building and architecture are the largest collections of the museum. Buildings need daily maintenance, especially because old buildings age quickly once they are no longer utilized. The use of the old building could bring vitality back to it. "Combining use and conservation" means using the building while preserving its architectural integrity. Modification to the original structure is prohibited.

The museum embraced a deliberate approach to the conservation of the building's architectural and cultural heritage. The interiors and exteriors were digitally modeled, and the repair, expansion and restoration were based on the model leaving the original architecture unchanged - this approach is translated literally as "restoring the old as the old". Several factors guide this process e.g. consideration for its prior use or restoration efforts. When the building was used as the Shanghai Library, the original grandstand was removed, and in the 1990s the museum's eastern facade was built in the style of the western facade. While taking these changes in consideration, the museum's management determined that the current renovation was consistent with the actual use of the building, and they kept the original style.

d. Dispose

As the building is intentionally conserved to prolong its life of use, the asset is not expected to be disposed of in the foreseeable future.

Management of Demand for Conservation

In addition to the museum building, there are two notable national conservation projects: the

Songze Cultural Ruins and the Yuan Dynasty Sluice Gate (1325) for which a significant conservation budget has been passed.

China has a heritage registration system for all cultural heritage artifacts. Cultural artifacts are classified and ranked, and this classification informs the value of the piece. This cataloging work was completed two years ago.

The process of cataloging cultural works helps determine the significance of an object and is taken into consideration to prioritize which artifacts will receive restoration funding. If the classification of the object determines that the piece can travel, it will be considered for exhibition elsewhere in China or abroad. If a cultural object is part of the permanent collection, there will be no assessment.

When conservation experts are needed in addition to those in-house, the museum engages in partnerships with other cultural administrations, e.g.: the architectural design institute for ancient sites, and for the conservation of pieces of extreme significance, the museum collaborates with universities.

The project procurement management process of the museum is comprehensive and efficient. For example, the development of the new museum building passed all reviews in three years, involving dozens of organizations, each determining that the museum had met their standards and requirements. Most of the reviews focused on the adequacy and accuracy of the budgets provisioned and whether the historical artifacts were exhibited to highlight their historical and cultural significance.

Visitors' satisfaction is measured by surveys taken in the museum, and the monitoring of hotline complaints and inquiries.

Challenges in Operations

For the next three to five years, the biggest challenge will be staffing and funding. Last year, due to the pandemic, museums across the country experienced budget shortfalls, exhibitions were canceled, and the Shanghai History Museum reduced its staff. As a result, many medium and long-term exhibitions were canceled or shelved. However, the visitors' volume was minimally impacted because the museum is located in the city center. Another challenge is the conservation of the sluice gate, as currently, there are no technological advances to preserve it.

Incorporating ESG Factors in Life Cycle and Demand Management

a. Environment

While the building of the Shanghai History Museum is 90 years old, its neighbor, the Shanghai Natural History Museum, is newly built with a contemporary design. A striking glass wall with a porous structure of plant and animal motifs allows ample natural light to shine through it. Rainwater is collected from the green roof and stored in ponds along with recycled graywater. The bioclimatic building responds to sunlight exposure through an intelligent building exterior that adjusts to daylight and sun exposure. An elliptical patio pool produces water evaporation that provides cooling, while the "intelligent" building's geothermal temperature management system adjusts energy consumption for both heating and cooling.

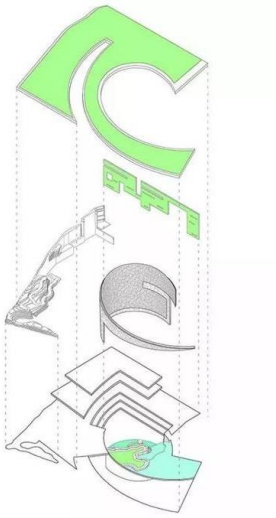

Figure 5. Structure of the New Shanghai Natural History Museum

b. Social Value

There are several types of collaborations and partnerships engaging the Shanghai History Museum with local communities. The museum's exhibitions are planned with consideration for the surrounding public parks, volunteers are solicited from the community office of East Nanjing Road, night market events with the Grand Theater are organized, and the local community police are encouraged to organize public education activities.

The museum also provides educational programs to complement schools' curricula. The students' engagement and feedback have been positive. Shanghai's secondary school students' mandatory extracurricular social activities credits can now be completed while participating in museum programs.

c. COVID-19 Responses

Social distancing, contact tracing apps and volume control pre-registration measures were imposed in order to ensure public health safety during the pandemic. Each visitor needs to have their temperatures checked and show their health pass in order to enter the museum.

Financial Management

To finance its operations, the museum receives funding from the treasury department of the Shanghai Municipal Government. Since it is categorized as a public asset, its funding is primarily from government grants; the income received from the museum operations is returned back to the treasury. The museum's financial budget is largely determined by the overseeing government agencies (including but not limited to the Cultural and Tourism Bureau).

Procurement of budgeted expenditures above RMB100,000 (about USD15,000) is determined by a regulated bidding process. However, the museum determines which of the bidding companies will be hired to run exhibitions. In general, the exhibition theme and realisation need to be approved and managed by an overseeing government agency.

All expenses made have to be included in a budget authorized by the city treasury. Expenses need to be itemized and justified based on a stated goal, to be considered for approval. The expenses approved are part of a fixed expense budget that will not be increased. The funding mechanism is designed to prevent asset managers from having to balance their budget ex-post. For example, the permanent exhibition is allocated a fixed annual budget that includes fixed expenses for utilities as well as all conservation expenses of cultural artifacts including those on loan to other museums. Each year, a new budget is submitted for approval.

Admissions to the museum is free of charge. Since 2004, all public museums have received full financial grants, with separate lines of income and expenses. The management trend is to allow some museums to apply the income revenues from their operations to the payment of their own operating expenses.

The Shanghai History Museum generates additional income revenues from renting the fifth floor of the museum to a restaurant. Another source of income revenues is generated from the rental of conference rooms as well as from the sales generated from their souvenir shops and educational activities and services provided to other institutions. The exchange of temporary exhibitions between domestic public museums involving regular exchange of collections, involves the exchange of artifacts or the profit sharing of the admission fees charged on loaned exhibits to other museums. On average, the admission fee is around RMB50 (approximately USD8) per person.

Case study 5: Vietnam's High-Speed Train Line

Background

This research project focuses on the "North-South Expressway-Eastern Side" high-speed train in Danang, Vietnam. This is a USD1.6 billion project, the first phase will link Hanoi to the city of Nha Trang by 2032. The last phase of construction is scheduled for 2045. The high-speed train is crucial and a consequential project that connects the northernmost and southernmost point of the country together, while passing through more than 20 provinces. The project is expected to have a large-scale effect on about 45% of the population in Vietnam impacting a swath of economic activities through various sectors including trade. The expressway is a symbol of national unity promoted by the government, who seek to demonstrate that its policies produce economic growth and prosperity for its population. In highlighting the good practices that apply to the North-South high-speed train, this case study seeks to highlight good infrastructure asset management practices against the backdrop of climate change. The "North-South Expressway-Eastern Side" high speed train is an infrastructure development project that echoes the UN SDG 8 on Decent Work and Economic Growth, SDG 10 on Reduced Inequalities, SDG 13 on Climate Action and SDG 17 on Partnerships for the Goals. This case study focuses particularly on the coastal region of Da Nang city's portion of the expressway, where climate change's negative externalities have impacted the region.

Figure 6. Vietnam's high-speed train.

Figure 7. Vietnam's high-speed train line

Life Cycle Management

a. Plan and Acquire

Vietnam's North–South express railway will replace the current North–South railway between Hanoi and Ho Chi Minh City. The completion of this historical capital investment is scheduled for 2040. It took 10 years to negotiate the purchase of equipment and material for the high-speed train. One of the most significant challenges was labor shortage. Inflation costs of raw inputs during the 2007-2008 financial crisis added a layer of complexity to fund the project.

Several reasons informed the government's decision to build the line. The development of the high-speed line is part of an economic development plan adding value to the national supply production chain expected to improve the welfare of 45% of the Vietnamese population. The high-speed train is also a strong symbol of the nation's unity following the ending of the Vietnam War in 1975. The reduction of transportation inequity between rural and urban populations, the discount fares offered to isolated communities (Vietnam includes 54 endogenous ethnic minorities), and the lower rate of fatalities on the road (attributed to traffic congestion), the reduction of road traffic and the air pollution it generates, were other positive externalities with a social impact that were considered and made a strong case for the development of the high-speed train line.

b. Use and Maintenance

To mitigate frequent extreme weather events the railroad operations and maintenance includes the replacement of old heavyweight rolling stocks with investment in new technologies supporting the use of lightweight electricity trains and the capacity to power double track train lines. Aging infrastructure such as tunnels, sleepers and ballast, will also be replaced with new ones. Adapting to extreme weather events (rising rainfall) and lowering energy consumption includes the renovation of bridges and increasing their height. Trains' operating schedules will focus on efficiency in terms of the quality of the service provided and energy consumed. The challenge for the Danang local authority is to be proactive in mitigating unexpected extreme flooding and reducing energy consumption. Contingency plans to mitigate extreme weather events and abnormally high precipitation during the rainy season is a concern and a challenge to be addressed. To that end, local authorities are focusing on preventive measures. The Danang local government will install rock formation sea walls to protect the assets from unlikely, but severe flooding damages. Dams will be built to reduce the impact of coastal erosion. Three-month maintenance cycles are put in place to preserve and extend the life of the assets. Simultaneously the condition of the assets will be continually monitored and assessed. The frequency of maintenance activities will improve the performance, and longevity of the assets.

In some localities, the asset management focus needed has been on ensuring passenger safety, updating existing telecommunication systems to minimize human errors, outfitting the train lines with micro-processing devices controlling electronic interlocking systems to stop trains and improving the level of safety, particularly during the flooding seasons.

The COVID-19 pandemic has slowed the completion of the line and asset managers of the train lines have had to adjust accordingly.

c. Disposal

Vietnam's initial north-south line was built by the French when the region was part of French Indochina. Its disposal and related costs are part of the high-speed train's first phase of construction. Maintenance and modernization of the high-speed train line is part of the asset management plan, its renovation will be ongoing, full disposal is unlikely until 2045 or until new transportation technologies emerge.

Financial Management

The Danang local government is using additional funding from the national assembly for emergency preparedness and is reducing the cost of procurement and construction costs by aligning the train tracks with the embankment areas. Collaboration with local communities is expected to reduce costs of operations and increase efficiency. The Da Nang local government is collaborating with the local population to limit the demand for non-essential activities requiring excessive use of clean water during the storm seasons. The increasing risk of climate-related sea water rise highlighted the necessity to build rock seawall barriers; their development also required them to build coastal roads as well. To meet these expenses, Danang local officials concluded that installing additional seawall barriers should be considered as a last resort to deal with the short to medium term risks and structured the funding to include 70% from government funds, 20% from the private sector and only 10% from other sources, including international organizations.

The Danang local authority recognizes the difficulties to price the cost included by natural disasters based on an evolving risk assessment. The management of the asset is working on assumptions to forecast a 10-year flood protection plan that captures the high ROI associated with the high-speed line as well as the opportunity cost of not mitigating climate risks.

Demand Management

Danang's local government wishes to incorporate principles of sustainability (economic, social and environmental factors, SEA) into management of its assets while accounting for convenience and integrated development. Answering the "why and how", is part of the management process focused on preserving the natural environment from natural disasters as much as minimizing noise pollution created by the high-speed train line. To that end, the Danang local authority has leveraged the mangroves to form a green barrier protecting the high-speed train infrastructure from more frequent extreme weather events. The adoption of low-carbon emission standards and other environmental measures aiming to decrease the externalities generated by dumpsites, coastal pollution and erosion.

A significant factor driving changes in demand are demographic changes. An estimated 50% of the passengers are young people, an encouraging statistic since the use of trains is more environmentally friendly than the alternative means of transportation, in the air or on the ground.

Case Study 6: System for Ecological Management and Waste Processing (SIMEPRODE) in Mexico

Background

Figure 8. SIMEPRODE

Bioenergía de Nuevo León, S. A. de C. V. (Benlesa) was the first renewable energy project in Mexico and Latin America that produced electricity from biogas extracted from a waste management facility. Benlesa is a public-private partnership between Bioeléctrica de Monterrey, S. A. de C. V. and the Government of the State of Nuevo León. This development is the genesis of a decentralized Mexican public waste management system, The Ecological Management and Waste Processing (SIMEPRODE), which has evolved to be profitable and self-sustainable. Benlesa uses the capture of methane gas from the landfill for the public lighting of the Monterrey Metropolitan Area, the consumption of government offices and the operation of the Monterrey Metrorail System. This has been one of the most emblematic projects of SIMEPRODE, being the first sanitary garbage landfill in Latin America that generates electricity and is 100% sustainable. This case study is a good example of infrastructure assets that aligns to the UN SDG 7 on Affordable and Clean Energy, SDG 9 on Industry, Innovation and Infrastructure; as well as SDG 11 on Sustainable Cities and Communities.

Life Cycle Management

a. Plan and Acquire

In 2003, SIMEPRODE obtained financing support from the World Bank to build an electric power generation plant with a capacity of 7.42 MWh generated from garbage (Monterrey I). Subsequently, in a constant growth scheme, the plant's capacity expanded to 12.4 megawatts in its second stage (Monterrey II) and in 2010, generated 17 megawatts in its third stage (Monterrey III). Now in 2021, it has an energy production of 20.8 MWh.

b. Use and Maintain

SIMEPRODE has an extensive infrastructure network dedicated to the collection, recycling, disposal, and production of electricity from urban waste. The collection rate of household waste in the metropolitan area of Monterrey is 92%, while in the suburban and rural areas, it is 80%. Most of the houses that are not included in the municipal collection waste disposal service, dispose of their garbage irregularly i.e. their waste is collected by informal collectors who primarily burn or dispose of the garbage in open air locations.

In the Monterrey metro area, there is about 30 thousand tons of waste collected regularly by neighborhood programs. The number of collection vehicles varies based on the size of the municipality and its population. In some municipalities, a single vehicle can serve 500 to 700 homes. In contrast, the Monterrey metro area has 90 collection units, each of them serving more than 3,000 homes. Organizing efficient waste collection routes has shown to be a key good practice. The collection infrastructure has shown to be as important as the processing and disposal of assets owned and operated by SIMEPRODE.

The SIMEPRODE metropolitan sanitary landfill is located outside of the metropolitan area. Approximately 400 people work at the selection and sorting plant. The landfill and plant are located in an area of 212 hectares and receive approximately 4,500 tons of waste per day, 3,500 of which is urban solid waste and the remainder require special handling care. More than 750 collection trucks enter the landfill daily.

Currently, SIMEPRODE has 13 landfills that serve 28 municipalities, and handles over 85 percent of the total waste generated. However, the rapid growth of urban centers makes it difficult to fully collect the growing volumes of waste produced in the city. The company highlighted that if additional investment and infrastructure is not provided in the near future, approximately 800 tons of waste will be disposed of in illegal land fields.

Public-Private Partnership

SIMEPRODE has been successful being able to achieve sustainable operations while growing for more than two decades. The electrical energy generated by SIMEPRODE through BENLESA, is sold to thirteen associated entities holding permits from the Energy Regulatory Commission (CRE): These entities include 9 municipalities, the Monterrey (railway system), and multiple government offices. Through purchase agreements, the company is able to generate the equivalent of USD12 million in operating profit per year.

Financial Management

It is urgent to raise additional funds to meet the increasing collection demand, separation and waste disposal for the city of Monterrey. A major challenge for SIMEPRODE has been to collect the rising amount of unpaid fees due by the municipal governments. According to SIMEPRODE, the

waste disposal fees charged to municipalities are only partially paid and, in some cases, accounted as past due.

Some municipalities do not allocate enough of its resources for waste management. Since public services related to waste and final disposal are not spending priorities they often delay or default on the payments owed to SIMEPRODE. Outstanding debts due, constrain SIMEPRODE's investments. The lack of technical or economic capacity to collect or dispose waste in rural areas outside of the Metropolitan area of Monterrey is another challenge.

a. Alternative Sources of Financing – Carbon Credits

Since 2006, SIMEPRODE has reduced emissions by up to one million tons of carbon and contributed to sustainability by producing biogas-based electricity. As of today, the plant produces 17 megawatts used by the public railway system, the state public lighting grid and municipal office buildings.

The 20.8 MWh of biogas-based electricity produced by Benlesa saves an estimated 51,484 metric tons of methane gas to be released in the atmosphere or the equivalent of 1,081,684 metric tons of Carbon Dioxide.

To offset the negative externalities of additional CO2 emissions, in 2016, SIMEPRODE and Benlesa issued USD11 million worth of carbon credits with the World Bank.

b. Alternative Sources of Financing – Tax Increase

To increase its capacity and modernize, SIMEPRODE has proposed to implement a statewide environmental charge that would be automatically included to the utility bills across the state.

A proposed environmental tax would allow SIMEPRODE to generate operating revenues at a profit and finance its growth while being environmentally sustainable. The environmental tax would also finance the acquisition of land for disposal, landfill cover material, engineering, testing and maintenance of landfills, the disposal of tires, batteries, oils and fluids and the monitoring and the management of its vehicle emissions. The environmental tax rate would be adjustable at the discretion of the government.

Demand Management

SIMEPRODE seeks to innovate and invest to optimize profits generated from its assets throughout their lifecycle, particularly seasoned assets. The waste management system in the state of Nuevo León has been operating for 30 years, and the landfill's useful life is expected to end in 2025. The continuous demographic growth of this state is increasing the demand for waste management plants and its existing capacity is insufficient to meet future demand. Thus, there is urgency to upgrade to a waste management technology with greater capacity that is also environmentally sustainable.

Conclusion on Findings of Good Practices in Infrastructure Asset Management

Our research findings on good practices of infrastructure asset management support UN DESA's recommendations for a portfolio approach to managing assets that results in operational and financial synergies. In China, the top-down approach of managing hospital resources from state to township levels, known as "the Medical Community," enabled them to scale up equal access and delivery of quality health services in containing the COVID-19 pandemic and allowed local hospitals to remotely offer medical experts to diagnose and treat patients from State hospitals. This research supports that infrastructure assets built in alignment with the UN SDGs can foster prosperity as well as social and environmental impact. China's Medical Community framework is aligned with the UN SDG 3 on Good Health and Well-Being, which played a critical role in containing the spread of the COVID-19 in China.

In the case of Mexico's SIMEPRODE, the financial management at the portfolio level, made it possible for the government to raise funds for the sustainability of its growing waste management operations, by issuing carbon credits, implementing environmental tax and creating public-private partnerships. Innovative design of infrastructure assets and the use of technology enhances performance and value of the assets. SIMEPRODE's focus on forecasting the increasing demand for sanitary landfills in Monterrey made the business case for seeking alternative financing sources to fund added capacity of waste management plants.

In Malaysia, the innovative design of the SMART Tunnel and technologies to operate the tunnel facilitated good practices to manage both flooding due to extreme weather conditions and traffic congestion in Kuala Lumpur. The SMART Tunnel's Flood Detection System, and its periodic assessment of flood damages through the Flood Hazard Maps, Flood Damage Maps, and Flood Risk Maps provide valuable data enabling good management practices and prioritizing flood mitigation operations.

In Vietnam, the high-speed train's good management practices leveraged its outreach and collaboration with civil society at the local level to manage extreme weather events. A 10-year plan provisioning for flood management and the preservation and maintenance of the asset, is also anchoring good management practices throughout. Structured and regular impact assessment changes relative to demand management and environmental sustainability, provides the basis for actionable economic estimates that substantiate additional investments to expand the capacity of existing assets. Finally, continuous and timely maintenance of assets ensure that they perform as intended while extending their life and use.

China's Oriental Beauty Valley ecosystem is a successful example of outsourced asset management services integrating technology. The development of a comprehensive supervision platform to strengthen information sharing, improve cross-departmental supervision and coordination and prevent and manage safety risks, contributes to the robust development of Beauty Valley as an infrastructure promoting the beauty and healthcare industries.

China's Shanghai History Museum's vision is aligned with the UN SDG 4 on Quality Education and SDG 12 on Responsible Consumption and Production while preserving Chinese culture and its historical legacy. This research highlights that the repurposing of assets can be successful when using a robust management of the assets' life cycle, as illustrated by the Museum's mission of "preserving by using".

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