AGREEMENT NO. CE 80/2017 (SP)

DEVELOPMENT OF A COMMON SPATIAL DATA INFRASTRUCTURE-
BUILT ENVIRONMENT APPLICATION PLATFORM
FEASIBILITY STUDY

EXECUTIVE SUMMARY

Analysis +

MAR
2020

Information +

+ DATA

規劃署
Planning Department

ARUP

Planning Department

Agreement No. CE 80/2017 (SP)
**Development of a Common Spatial Data Infrastructure -
Built Environment Application Platform – Feasibility Study**

Executive Summary

REP-007-03

Final | 10 March 2020

Job number   260573

ARUP

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

Contents

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

Abbreviations and Acronyms

AI	Artificial Intelligence
API	Application Programming Interface
AR	Augmented Reality
AURIN	Australian Urban Research Infrastructure Network
BDAP	Big Data Analytic Platform
BEA	Built Environment Applications
BEAP	Built Environment Application Platform
B/Ds	Bureaux/Departments
BIM	Building Information Modelling
CGIS	Corporate Geographic Information System
CGSIP	Common Geospatial Information System Platform
CPU	Central Processing Unit
CSDI	Common Spatial Data Infrastructure
CSDSC	Common Spatial Data Steering Committee
DEVB	Development Bureau
GFA	Gross Floor Area
GIC	Government, Institution and Community
GIS	Geospatial Information System
GPU	Graphics Processing Unit
HKPSG	Hong Kong Planning Standards and Guidelines
ICT	Information and Communications Technology
IoT	Internet of Things
ISO	International Organization for Standardization
LiDAR	Light Detection and Ranging
OGCIO	Office of the Government Chief Information Officer
OS	Operation System
PlanD	Planning Department
PoC	Proof of Concept
SGR	Smart, Green and Resilient
UAV	Unmanned Aerial Vehicle
VR	Virtual Reality

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

1 INTRODUCTION

1.1 Background

1.1.1.1 As announced in the 2017 Policy Address, the Government is striving to promote the establishment of CSDI to provide B/Ds as well as the public and private organisations with an information infrastructure to share spatial data, support various smart city applications, and the initiatives of the "Smart City Blueprint for Hong Kong" (the Blueprint). The CSDI and the application of ICT have also been recognized as pivot means to achieve the strategic vision to plan Hong Kong as a "Smart, Green and Resilient (SGR) City Strategy" championed under "Hong Kong 2030+: Towards a Planning Vision and Strategy Transcending 2030" (Hong Kong 2030+).

1.1.1.2 To put forth the development of CSDI initiative, DEVB in 2018 completed a consultancy study on the overall strategy for the CSDI implementation, which is to formulate an effective CSDI development strategy for the purpose of land and infrastructure planning development and management in Hong Kong. Meanwhile, PlanD has also embarked on a feasibility study on "Development of a Common Spatial Data Infrastructure - Built Environment Application Platform" (the Study) in March 2018 to explore the establishment of the BEAP and use of spatial data in developing built environment applications, following the development strategy of CSDI.

1.1.1.3 This Assignment aims to take forward the CSDI development strategy and support the Blueprint, the Hong Kong 2030+, the built environment related CSDI initiatives and other relevant studies' recommendations, by formulating an overall development framework covering different key aspects in the short, medium and long term and demonstrating with test case through proof of concepts and prototypes of a number of applications for the establishment of the CSDI BEAP focusing on city planning, infrastructure/engineering, and environmental applications. This Assignment, other than examining feasibility, also serves as a demonstration case of CSDI to further support and provide early delivery of tangible benefits to users.

1.1.1.4 The BEAP aims to foster co-operation, collaboration and co-creation with Government departments through application and data/information sharing, and knowledge building for mutual benefits, before extending to business, academia and the public. It is expected that BEAP would provide a number of common and thematic applications for users to conduct analysis to support the work of B/Ds.

1.1.1.5 The BEAP will focus on key aspects of the built environment applications in relation to city planning, infrastructure/engineering, and the environment of Hong Kong, in particular those under DEVB, and cater for short, medium to long term development. It is understood that data and application need to be integrated together in order to maximize the meanings they bring, therefore under the CSDI initiative, the BEAP would improve efficiency, transparency and the support for decision making in planning and development, and hence, fostering interdepartmental co-operation and synergy for policy formulation, decision making, resource management, as well as the delivery of high quality services to the public (**Figure 1.1**).
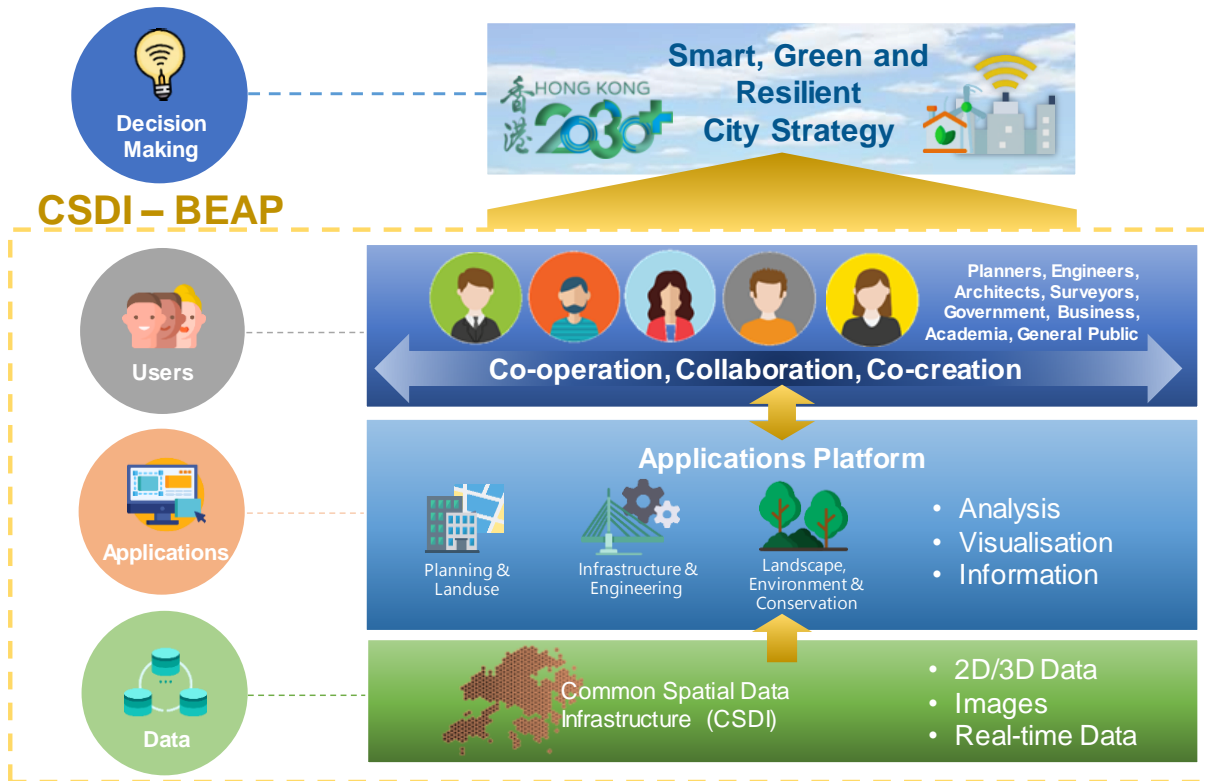
Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

Figure 1.1 – CSDI-BEAP Study

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

1.2   Study Process

1.2.1.1   PlanD commissioned Ove Arup and Partners Hong Kong Limited (the Consultant) on 5 March 2018 to undertake the "Development of a Common Spatial Data Infrastructure – Built Environment Application Platform – Feasibility Study" (the Study). The assignment comprises two study stages. Stage 1 is the study and formulation of a development framework and Stage 2 is the development of a test case for BEAP.

1.2.1.2   Key tasks for Stage 1 include:

a)   conducting a desktop review of built environment application platforms and systems implemented or being implemented by other international smart cities, governments and agencies, and/or public service operators that are related to city planning, infrastructure/engineering development and the environment; and

b)   formulating an overall CSDI BEAP framework with goals and targets as a roadmap covering short, medium and long terms for the gradual implementation of CSDI and smart city initiatives, identifying potential built-environment related applications, formulating BEAP development plans with objectives, scope, applications, technology development, and implementing and phasing to enable the gradual implementation of the BEAP in short, medium and long terms.

1.2.1.3   The conceptual model of BEAP was developed in the course of formulating the overall CSDI BEAP framework based on the four building blocks and corresponding principles as derived based on the findings from the Desktop Review and stakeholder involvement. Based on departmental visits to B/Ds, selection and prioritization criteria and subsequent synergy workshop and stakeholders' engagement meeting, potential application types were then identified for further investigation and development.

1.2.1.4   Stage 2 formulated and established a test case for the future development of the BEAP to demonstrate that the identified applications could be applied to support work of B/Ds through proof of concept and demonstrate the feasibility through prototyping of applications for the future development and implementation of the BEAP.

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

2 REVIEW OF INTERNATIONAL AND LOCAL EXPERIENCES

2.1 Desktop Review on International Case Studies

2.1.1.1 The consultancy study started with a desktop review of built environment application platforms and systems implemented or being implemented by other international smart cities, governments and agencies, and/or public service operators relating to city planning, infrastructure/engineering and the environment. The focus of the review is on the business purpose and services of the platform, the functionality and potential value of the services to the BEAP, implementation process and phases, key dependencies for the platform to function effectively; and any lessons learnt in relation to the above-mentioned.

2.1.2 Selection Criteria for International Case Studies

2.1.2.1 In selecting the international cities as case studies, the following criteria were used (in order of importance):

- Relevance to the Hong Kong BEAP – i.e. whether it performs the same or similar function to that proposed for the BEAP;

- Relevance to the Hong Kong conditions – i.e. whether the platform belongs to a city with similar geography, population, political structure, planning challenges, etc.;

- Whether the platform has been acknowledged by others as an example of best practice;

- Platforms with varying implementation characteristics to enable comparison of the different approaches that have been taken;

- Whether the platform and/or responsible authority offers useful lessons for Hong Kong; and

- Availability of key information about the platform and its applications – i.e. whether the information needed can be obtained from publicly available resources, including independent reports or articles about the platform; whether additional information from the platform operators/responsible authority were available for collection.

2.1.2.2 The three case studies including Singapore - Virtual Singapore, Australia - Australian Urban research Infrastructure Network (AURIN) and Portland - Corporate Geographic Information System (CGIS) provide a broad coverage of different implementation approaches. In reviewing the strengths and weaknesses of each, the approaches taken by the case studies have been compared and contrasted in relation to the ambitions of the BEAP to identify lessons that can be learnt.

- Virtual Singapore: a recent city-wide implementation with a focus on 3D data and city model to specifically address built environment issues. It employs a proprietary technology platform that is hosted in the cloud environment.

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

- AURIN: a national urban information and applications platform driven by academia. It is characterised by the federated nature of the participants, the use of open source technologies and internal self-hosting model.

- CGIS: a successful long running city-wide programme that took a centralised approach, uses commercial software running on a mix of in-house and cloud hosted services and has embraced an open data approach to collaboration.

2.1.3 Key Findings of International Case Studies

Virtual Singapore - Singapore

2.1.3.1 Virtual Singapore is championed by a National Research Foundation (NRF), as well as the government's land authority and technology agency. NRF will be leading the project development, whilst the land authority will support with its 3D topographical mapping data and become the operator and owner when Virtual Singapore is completed. The technology agency will provide expertise in information and communications technology and management as required in the project. There are ongoing collaborations with government agencies, universities and partners to leverage this platform for their modelling and simulation needs.

2.1.3.2 As part of Singapore's "Smart Nation" strategy, the main goal of Virtual Singapore is to develop a common data exchange platform, making much of the data that already exists in government ministries easier to be accessed and shared in a secured and controlled environment. Visualization is a major goal of the project so that the aggregated and integrated data from different sources including BIM and GIS, can be "seen" in an object based virtual 3D model. Based on the 3D visualization on one platform, it can offer additional benefits to enhance collaboration, simulate scenarios on underground and coastal expansion, and increase communication across government departments and public communities, etc.

AURIN – Australia

2.1.3.3 Established in June 2010, the AURIN is an initiative of the Australian Government under the National Collaborative Research Infrastructure Strategy (NCRIS) and associated programmes. AURIN is a collaborative network of leading researchers and data providers across the academic, government, and private sectors that provides:

- a one-stop online portal with more than 3,500 multi-disciplinary datasets, from over 98 different data sources (the AURIN Portal); and

- a suite of additional open-source tools and applications, covering spatial and statistical modelling, planning and visualization (the AURIN Workbench). AURIN aims to provide urban and built environment researchers with access to diverse sources of data, data integration capabilities, and an e-research capability for interrogating those data.

2.1.3.4 Funded by the Australian Government through the Education Investment Fund, and the National Collaborative Research Infrastructure Strategy, AURIN initiative is building the e-research infrastructure to enable better understanding of the current state of Australia's cities and towns and to meet the challenges they are facing.

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

AURIN enables Australian planners and researchers to make informed decisions about future infrastructures and urban environments based on realistic scenarios and evidence-based analysis.

CGIS –Portland, USA

2.1.3.5   The city of Portland in Oregon, USA is an early adopter of a citywide spatial data infrastructure and provides a good case study of a proven and successful approach in sharing spatial data via a centralised corporate function. The CGIS and the Portland Enterprise GIS Hub (EGH) have been described in numerous articles and publications over the years. The information provided in the case study was gleaned from the Consultant's direct involvement in development of the EGH and from recent discussions with the CGIS Manager at Portland.

2.1.3.6   The CGIS is a business unit within the Bureau of Technology Services (BTS). Its role is defined within City policy as "to ensure the City leverages existing investments, eliminates redundancy, promotes standardisation and consolidation and provides business efficiencies to the City using scalable enterprise GIS technologies". It achieves this by providing several functions:

- Supplies master data and business intelligence
- Provides corporate spatial data warehouse and data integration facilities
- Provides application development services

2.1.3.7   **Table 2.1** summarises the key findings of international case studies.

	Virtual Singapore	AURIN	CGIS
Purposes	• A 3D identical twin with virtualization, simulation and collaboration capabilities on top of existing data in the government	• Complex information to be accessed by various parties for decision making based upon realistic scenarios and evidence-based analysis	• Improve city services and efficiency by simplifying access to common spatial data using centralised corporate function and enterprise GIS technologies
Funded by	• National Research Foundation - Prime Minister Office, Singapore	• Education Investment Fund of the Australian Government	• Bureau of Technology Services of the City of Portland
Strengths	• Application-focused with data as an enabling factor • "Single source of the truth data" for data processing	• Establishment of a "Workbench" which is a web-based suite of data discovery, visualization,	• Provide corporate spatial data warehouse and data integration facilities to support city business functions

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

	Virtual Singapore	AURIN	CGIS
	• Strong support for collaboration and public engagement	analytical and planning tools • Open source data and software • A dedicated team to manage and develop the platform	• System is responsive to user through optimization of each application
Relevance to Hong Kong	• Deployment of cloud technology • Right mix of software, development and domain experts to trigger applications across disciplines	• Act as a portal (broker) to the data rather than being a repository • Technology neutral software and hardware	• Use of proprietary software, but implication of high license costs and difficulty in customization • A core development team to address a wide range of business needs

Table 2.1 – Key Findings of International Case Studies

2.2   Local Experience

2.2.1.1   Apart from international case studies, this Study has also reviewed the local experiences regarding development of built-environment applications and platform to enable better use of the available data.

Public Sector Information (PSI) Portal

2.2.1.2   In recent years, the Government has also been working towards enabling the sharing of spatial and non-spatial data through the establishment of the portal. To step up the setting up of PSI portal for release of the Government information /data to the public, the Financial Secretary announced in the 2015-2016 Budget that all Government information/data would be released in digital formats free online. In 2015, the OGCIO launched the revamped PSI portal (data.gov.hk) to encourage more creative re-use of data. The portal provides more than 4,000 datasets in 18 broad categories such as weather, health, population and transport.

Hong Kong 2030+

2.2.1.3   Hong Kong 2030+, which is a comprehensive strategic study to update the territorial development strategy built upon the foundation of the "Hong Kong 2030: Planning Vision and Strategy" promulgated in 2007 and has revisited the planning strategy and spatial development directions beyond 2030 in the light of the dynamics and challenges ahead. It represents the Government's vision, policy and strategy for the territorial development of Hong Kong beyond 2030. A visionary, proactive, pragmatic and action-oriented approach is adopted to ensure a focused

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

public dialogue on the key planning issues critical to future development and a timely response to the changing circumstances in and outside of Hong Kong[1].

The Blueprint

2.2.1.4   Released in December 2017, the Blueprint[2] outlines the vision and mission to build Hong Kong into a world-class smart city by mapping out development plans and providing a clear and concrete direction for smart city development in Hong Kong. The vision of the Blueprint is to "embrace innovation and technology to build a world-famed Smart Hong Kong characterised by a strong economy and high quality of living" with the following missions set:

- to make people happier, healthier, smarter and more prosperous, and the city greener, cleaner, more liveable, sustainable, resilient and competitive;

- to enable the business to capitalise on Hong Kong's renowned business-friendly environment to foster innovation, transform the city in a living lab and test bed for development;

- to provide better care for the elderly and youth and foster a stronger sense of community. To make the business, people and Government more digitally enabled and technology savvy;

- to consume fewer resources and make Hong Kong more environmentally friendly, while maintaining its vibrancy, efficiency and liveability

Common Geographic Information System Platform (CGISP)

2.2.1.5   In view of data of various B/Ds stored under different systems and formats according to individual departments' requirements to support their own operational needs, a feasibility study to explore the establishment of CGISP was commissioned under the Detailed Design Study for the Fanling North (FLN) and Kwu Tung North (KTN) New Development Areas (NDAs) to examine possible ways to establish a coherent information system to assist the NDAs development, as well as to facilitate planning, construction, monitoring and maintenance work; decision making and public consultation.

Study on Development Strategy of a CSDI (CSDI Study)

2.2.1.6   With the release of the findings of HK2030+ and the Blueprint, the importance of spatial data as a strategic asset for Hong Kong is duly recognised. In 2017 Policy Address, the establishment of the CSDI was mentioned under the umbrella of the smart city. The Government has committed to develop CSDI in order to provide Government departments as well as public and private organisations with an information infrastructure to share spatial data, support various smart city applications, and support the implementation of smart city. In 2017, DEVB commissioned the CSDI Study, which formulated an effective development framework and implementation to take forward CSDI initiative from a "joined-up government" and "spatially enabled society" perspective with initial focus on land and infrastructure planning, development and management in Hong Kong.

---

[1]   http://www.hk2030plus.hk/index.htm
[2]   https://www.smartcity.gov.hk/

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

Developing Kowloon East into a Smart City District – Feasibility Study (Kowloon East Study)

2.2.1.7   In the 2015 Policy Address, the Chief Executive stated that the latest Digital 21 Strategy envisioned that the Government would make wider use of sensors, IoT and big data analytics for better public services and sustainable social and economic growth. Moreover, it was announced that the Government would use Kowloon East as a pilot area to explore the feasibility of developing a smart city. The Kowloon East Study is commissioned in early 2016 to review, investigate, and produce feasible development options and implementation strategy to develop Kowloon East into a smart city district in terms of its strategic setting, constraints and opportunities.

2.3   Findings of Departmental Visits

2.3.1.1   During the course of the Study, the Consultant has conducted visits to various B/Ds in order to have a quick investigation on the necessary applications, information and related data/datasets.

2.3.1.2   Key observations from departmental visits are listed as below:

- Each department has its own system for asset search and visualization, which is specific for their own operations, making it a difficult task to identify an application that can include all departments;

- One common denominator of requirements of departments is to be able to have a common data platform/ planning & technical information review hub to facilitate speedy and accurate data/ information exchange and review;

- Data acquired from other departments are often updated by request or periodically, and most of time are not the latest version as a result;

- Most data of departments are updated manually or by contractors according to their own management systems;

- Most data of departments are 2D based and some of them are not spatially ready nor geo-tagged; and

- Due to sensitivity and confidentiality concerns, some of the departmental data may not be able to be shared easily.

2.4   Key Lessons Learned from Overseas and Local Experiences

2.4.1.1   On the basis of lessons learned from the overseas case studies, local experiences and the Consultants' own assessment of current developments and best practice in the built environment application realm, there are four key building blocks that need to be considered for the successful implementation of the BEAP. Within each of these key building blocks, a set of essential components should be taken into account in the course of future development of the BEAP, which are shown as below:

Application Development

- **A wide range of applications** – The BEAP should provide a wide range of applications from cross-sector sources via an application portal

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

- **Standardised APIs for applications** – The BEAP should publish standardised APIs to encourage and enable application development

- **Application-focused with data as an enabling factor** – The setup of the BEAP and the functions it provides should be driven by the end users

- **Open standards in applications development** – Applications hosted by the BEAP should be built to open standards

Actionable Data for Applications Development

- **Actionable data**[3] **–** A wide range of actionable data should be made available to support the use cases and applications, with a focus on open data standards and licensing

- **Open standards for actionable data** – Just as the use of open standards in application development is highly desirable, the BEAP should consider the adoption of open standards for any actionable data it produces

Technical Infrastructure

- **Relationship with the CSDI** – The BEAP should be supported by the CSDI (and/or other corporate function(s)) which provide access to the fundamental or/and common sharable data required by the applications

- **Innovative platform** – The BEAP should be an innovation-oriented platform with an open, flexible and scalable supporting infrastructure and platform design that is vendor-agnostic

- **Security and access controls** – Appropriate security and access controls should be well embedded into the BEAP

Business Architecture and Operating Model

- **Clear strategic vision** – A clear strategic vision, direction and scope for the BEAP is essential

- **Valuable business services** – The BEAP should provide a set of services tailored to the needs of decision makers and built environment professionals.

- **Executive level sponsorship** – The BEAP should have executive level sponsorship with strong financial backing, clear funding model, robust institutional setup and legal framework

- **Well-defined governance model –** The BEAP should have a well-defined, inclusive governance model

- **Collaborative operational model** – The BEAP should employ a needs-led, ground-up, cross-sector collaborative operational model

- **Dedicated team of specialists –** A team of dedicated specialists and domain experts are fundamental to the success of building, operating and developing the BEAP

---

[3]   "Actionable data" is a term used in the IT (and spatial) industry for at least the last decade. Typically, actionable data is: Available (ready to be used by the applications); Useful (able to be acted on); Relevant (content of the data is relevant to the query that is being made of it). Based on the findings of the three overseas cases, actionable data was found as a fundamental element of an application platform, therefore it is recommended for the development of BEAP.

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

3 OVERALL DEVELOPMENT FRAMEWORK OF THE BEAP

3.1 BEAP Mission

3.1.1.1 The BEAP will function as a Centre of Excellence (CoE) for built environment applications in Hong Kong by providing a focal point that brings together relevant expertise from throughout the city to promote collaboration in the development and sharing of best practices and knowledge.

3.1.1.2 It will provide a set of applications developed for specific needs of the built environment. If an application is identified as relevant to multiple users, it can be accepted as a common application in the context of the CSDI upon the endorsement of the CSDSC.

3.1.1.3 The BEAP is geared towards facilitating the application of ICT in city planning, infrastructure/engineering, and environmental works, which aims to improve works of B/Ds with applications.

3.1.1.4 More importantly, the BEAP aims to improve efficiency, transparency and support for decision making in planning and development, and hence, fostering interdepartmental co-operation and synergy for policy formulation, decision making, resource management, as well as the delivery of high quality services to the public.

3.2 BEAP Conceptual Model

3.2.1.1 Based on the findings from the desktop reviews and departmental visits, an overall development framework which guides the progressive development and implementation of the BEAP are proposed. Critical components and factors for success of the BEAP have been identified and the measures leading to its success are recommended as well.

3.2.1.2 The conceptual model indicating the four building blocks and the main elements therein are illustrated in **Figure 3.1**.
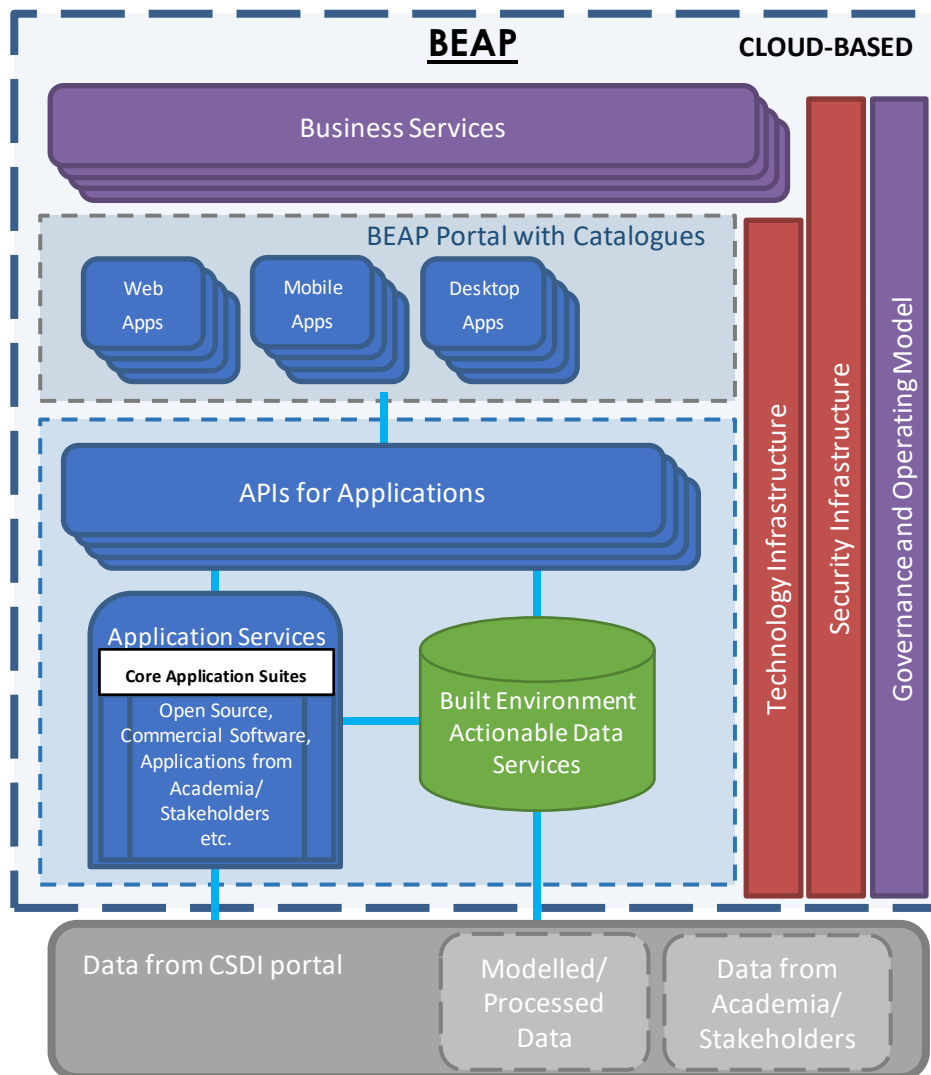
Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

Figure 3.1 – The Conceptual Model

3.2.1.3   The content of each element under each building block is described as follows:

Applications Development

- **BEAP Portal with Catalogues:** A web-based portal serves as the users' access point to the BEAP applications. It provides an applications services catalogue that allow users to search for and access to the required services. The portal could also provide collaboration tools to enable professionals to work together.

- **Built Environment Applications:** Through the BEAP portal, the applications are tasked to address specific built environment requirements. The applications include online Web Apps, Mobile Apps, or downloadable Desktop Apps from the Application APIs.   Applications, data and collaboration tools are listed and searchable through the Catalogues provided in the portal.

- **APIs for Applications:** Common built environment application functionality may be hosted online and exposed to other application developers via standard/open APIs. These APIs can be further linked with the CSDI which would enable a more effective and efficient access to the source data.

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

Data for Applications Development

- **Built Environment Data Services:** Datasets obtained from the CSDI portal would be specifically processed or 'enriched' to support the needs of built environment applications.

Technical Infrastructure

- **Technology Infrastructure:** The fundamental hardware and software on which the BEAP applications and data reside and operate.

- **Security Infrastructure:** The security policies, procedures, user control, tools and resources to ensure that any sensitive information used in the BEAP would not be released to whom should not have the right of access.

Business Architecture and Operating Model

- **Business Services**: The services provided by the BEAP to the user community such as application development, application hosting, etc. Applications provided to different user communities such as B/Ds, academia and public can be different.

- **Governance and Operating Model:** The legal basis for the BEAP, together with the appropriate policies, accountabilities, organisational setup and governance structure to ensure that the BEAP operates efficiently and effectively and delivers value.

3.2.1.4 To implement the BEAP conceptual model, four plans, namely Application Development Plan, Technology Development Plan, Business Development Plan and Implementation Plan are proposed. The ideas of these four plans are illustrated in the ensuing sections.

3.3 Application Development Plan

3.3.1.1 The application development plan consists of applications and data architecture, corresponding to the applications and data building blocks of the BEAP conceptual model.

3.3.2 BEAP Portal with Catalogues

3.3.2.1 The BEAP curated collections of applications and services will be accessible via a web portal (the **BEAP Portal**) that will enable users to engage with the BEAP and discover relevant resources via application gallery.

3.3.2.2 An applications catalogue (i.e. linking to **Web Apps**, **Mobile Apps** and **Desktop Apps**) will enable users to search for, interact with, or download built environment applications. The distinction between application and web map can be rather blurred as mapping platforms enable maps to be published as applications, complete with the specific tools for each application.

3.3.3 APIs for Applications

3.3.3.1 In order to maximize the value that may be obtained from the built environment applications in Hong Kong, the applications must be made available in an accessible manner. Rather than requiring users to download applications, application services enable applications to be stored centrally and served online via http web addresses (URIs). APIs enable a wide variety of software applications to

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

access online functions by providing a published interface to the applications via a set of programmatic functions that can be used directly by external programs to access and use the applications.

3.3.4   Built Environment Actionable Data Services

3.3.4.1   According to the proposed conceptual model, the BEAP will develop a set of territory-wide information products that are tailored to support built environment applications. These "actionable" datasets will be designed to enable applications to work responsively and seamlessly across the territory. They will take the "common spatial data" from the CSDI and process it to produce "built environment-specific spatial data" that is optimised and ready for use within built environment applications. This spatial data, if become sharable and discoverable, can be fed to the CSDI portal for dissemination.

3.3.5   Access to Source Data

3.3.5.1   Upon implementation of CSDI, CSDI would serve as the main data sources to support the operation of the BEAP and the applications. There are other enterprise initiatives that could potentially influence the form and function of the CSDI and BEAP such as: Master Data Management, Data Warehousing, Business Intelligence, Real-Time data, IoT/Sensor data, Big Data Analytics, Records Management, Electronic Document Management and Smart Cities.   The relationships between the CSDI, BEAP and other related enterprise initiatives are evolving and may present opportunities for improved ways of working. Close liaison will be kept with the responsible agent of CSDI regarding the use of data during the implementation stage of the applications.

3.3.6   Identification of 30 Application Types

3.3.6.1   In the Stage 1 of the Study, 30 application types have been identified and consolidated taking into account the requirements of the Study Brief, feedback collected from B/Ds and departmental visits, which set out the direction for development of proof of concepts of the test case for the BEAP. Details of the 30 application types identified are shown below:

1. Site Search for Housing, Land and Government Facilities
2. Planning and Development Review and Impact Assessment Review Platform
3. Landuse Monitoring and Analytics, Data Update Mechanism through Artificial Intelligence (AI)
4. Appraisal of Development Proposal
5. Connectivity Analysis
6. Scenario Generation – Development and Design Toolset
7. GIC Facilities and Open Space Analysis
8. Digital Underground Space and Utilities
9. Visualization of Existing and Planned Development and Infrastructure Projects in Hong Kong and Greater Bay Area
10. Visualization and Analysis of Green / Blue, Socio-economic, Demographic, Conservation, Heritage, Agricultural Information
11. City Critical Information Sharing Platform
12. Real Time Internet of Things (IoT) Analytics
13. Public e-Engagement platform

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

14. Future redevelopment
15. Noise assessment
16. Air quality assessment
17. Traffic impact assessment
18. Air Ventilation assessment
19. Environmental impact assessment viewer
20. Building plan and proforma checking
21. BIM/GIS integration
22. Tree management system
23. Data update and plan production automation tool
24. Data inventory and document retrieval system
25. Common platform for departmental data
26. Mobile apps for site inspection
27. Visualization tool of analysis result
28. Peer to peer group chat for projects and events
29. Integration of smart phone and AR/VR
30. Automatic notification of data updating

3.3.7 Selection and Prioritization of Potential Application Types

3.3.7.1 With the general ideas of the application types identified in the above section, a set of principles and criteria have been derived to enable the identification and prioritisation of potential application types for the BEAP. This following section explains the principles and criteria to be adopted to assess the potential application types.

Key Principles of Selecting Potential Application Types

3.3.7.2 Among 30 application types identified, the following principles were derived taking into account the requirements of Study Brief and the findings of departmental visits:

1. Benefits to more users – one of the aims of the BEAP's applications is to encourage co-operation, collaboration and co-creation among B/Ds.

2. User driven – applications can facilitate and enhance the daily operational work for B/Ds.

3. Policy driven – each B/D has works that are required by key Government policy and initiatives, or as part of department's obligatory duty
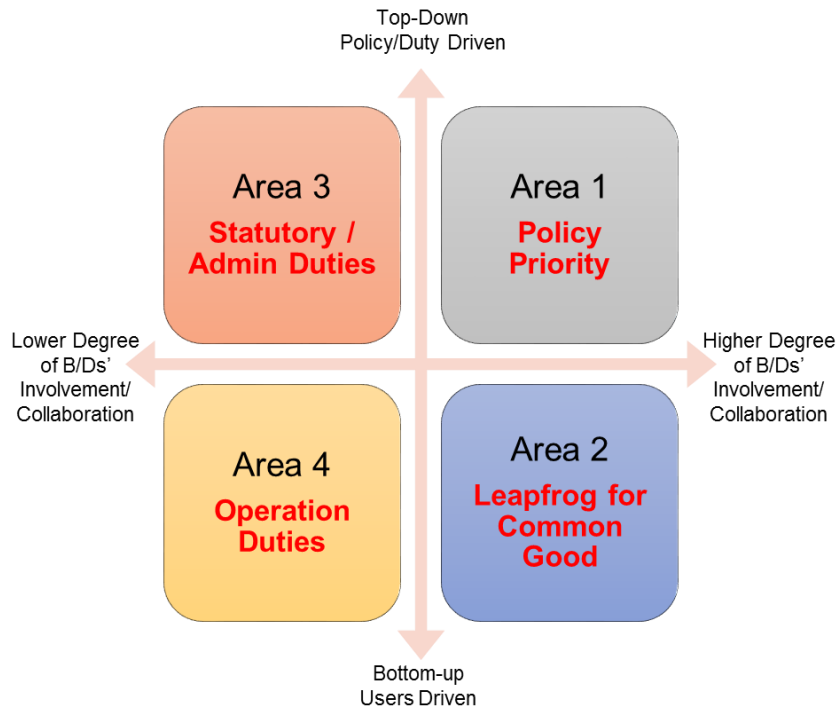
Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

Figure 3.2 – Four-quadrant Matrix for Potential Application Types

3.3.7.3   A four-quadrant matrix (**Figure 3.2**) is developed according to the above principles.   The horizontal axis assesses the degree of involvement and collaboration of B/Ds. The vertical axis identifies the initiative of the applications, whether it is policy driven or user driven. Using the matrix, potential application types can be categorised into the following 4 areas:

- Area 1: Policy Priority – potential applications that are required by key Government policy and initiatives, or as part of department's obligatory duty that involved multiple B/Ds

- Area 2: Leapfrog for Common Good – potential applications that has common use and functionality that are demanded by multiple B/Ds

- Area 3: Statutory/ Administrative Duties – potential applications that are required by key Government policy and initiatives, or as part of department's obligatory duty of one or a couple of B/Ds.

- Area 4: Operation Duties – potential applications that would facilitate specific task or operational work of B/Ds. The applications in Area 3 and 4 might require information from other B/Ds but the application itself is only beneficial to one or a couple B/Ds.

3.3.7.4   These principles provide a selection mechanism for the BEAP application development in a long run.   It is anticipated that users and developers will take advantage of the BEAP environment, where common applications and data services are readily available, and develop applications in all 4 areas. While it would be easier for B/Ds to come up with application ideas for their own use under Area 3 and 4, it is encouraged to develop a good mix of applications in all 4 areas to increase collaboration and reduce duplicate effort among users.

3.3.7.5   At the initial stage, it is suggested to preliminarily focus on the applications that fall within Area 1 and 2, which collaborate and facilitate multiple B/Ds. This would

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

allow the BEAP to get more users involved at an early stage and allow them to understand the BEAP environment quickly.

<u>Criteria for Prioritising Potential Application Types</u>

3.3.7.6 On the basis of the above selection principles, the following criteria are also used to further shortlist the most appropriate application types:

- *Application area/Topic* – fall under the 3 thematic areas: Planning & Landuse; Infrastructure & Engineering; Landscape, Environment & Conservation as specified in the Study Brief
- *Fit with BEAP objectives* – encourage and foster high level of co-operation, collaboration and co-creation
- *Scalability* – capable to demonstrate usability in smaller scale with the capacity to scale up in four different aspects in mid-long term: functionality, data, spatial coverage and user base.
- *Data readiness* – availability of required data and prerequisite technology maturity
- *New Technology* – embrace the leading-edge technology development

3.3.7.7 With the adoption of the afore-said selection principles and evaluation criteria, the following 12 potential application types have been identified:

1. <u>Site Search for Housing, Land and Government Facilities</u>
   A one-stop decision making platform for B/Ds to search for sites with various selection criteria

2. <u>Planning and Development Review and Impact Assessment (IA) Review Platform</u>
   An integrated platform for B/Ds to upload and share their input/concerns on development plans and IA reports

3. <u>Landuse Monitoring and Analytics, Data Update Mechanism through Artificial Intelligence (AI)</u>
   An integrated platform for detecting any changes in landuse and abnormal activities in a designated area through AI and machine learning

4. <u>Appraisal of Development Proposal</u>
   An integrated platform to assist B/Ds in assessing and tendering comments on the development proposals through access to and analysis of relevant information

5. <u>Connectivity Analysis</u>
   A tool to identify access and routing to work, business, public amenities, neighbourhood facilities, recreational opportunities, nature, etc.

6. <u>Scenario Generation – Development and Design Toolset</u>
   A planning toolset to enable a quick generation of different preliminary design scheme options with input of planning parameters for scenario testing and to visualize the impacts of the design scheme on the surrounding developments

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

7. <u>GIC Facilities and Open Space Analysis</u>
A tool to assess GIC facilities and open space with spatial dimension in accordance with the requirements of HKPSG

8. <u>Digital Underground Space and Utilities</u>
An integrated platform for B/Ds to update and upkeep the record of the underground utilities with adjustable Level of Details (LODs) as well as to facilitate forward planning for underground space

9. <u>Visualization of Existing and Planned Development and Infrastructure Projects in Hong Kong and Greater Bay Area</u>
An integrated platform for B/Ds to visualize existing and planned development and infrastructure projects in Hong Kong and the Greater Bay Area

10. <u>Visualization and Analysis of Green / Blue, Socio-economic, Demographic, Conservation, Heritage, Agricultural Information</u>
An integrated platform to visualize and analyse landscape character, green/ blue cover, vegetation density, renewable energy potential, conservation and agricultural information, historical heritage, etc.

11. <u>City Critical Information Sharing Platform</u>
An integrated platform to visualize and analyse the key built environment information of Hong Kong, namely socio-economic data, infrastructure projects, traffic flow survey, temperature, air quality, census data, etc.

12. <u>Real Time IoT Analytics</u>
An IoT application tool to enable visualization and analysis of the built environment related data collected from real-time sensors to facilitate provision of city related services

3.3.8 Synergy Workshop and Stakeholders Consultation Meeting

3.3.8.1 With the identification of 12 potential application types, a Synergy Workshop with various B/Ds[4] was held on 19 June 2018 to introduce the conceptual ideas of these application types. During the workshop, a voting had been carried out among the participant B/Ds to select the application types that were most interested in and yielded mutual benefits to them and also considered to be more imperative. Separately, a Stakeholders Consultation Meeting[5] with representatives from the academia, professional institutes and organizations was held on 22 June 2018 to solicit their views on the application framework, development and associated issues.

---

[4]   Representatives from relevant B/Ds including AFCD, ASD, BD, C&SD, CAD, CEDD, DEVB, DSD, Efficiency Office, EMSD, EPD, HyD, HD, LandsD, LCSD, OGCIO, PlanD, RVD and WSD attended the workshop.

[5]   Representatives from The Hong Kong Polytechnic University, The University of Hong Kong, The Hong Kong University of Science and Technology, The Hong Kong Institute of Planners, Hong Kong Institution of Engineers and Smart City Consortium attended the meeting.

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

3.4   Technology Development Plan

3.4.1.1   The Technology Development Plan outlines the planning for the third building block of the BEAP conceptual model – the technical infrastructure. Details are illustrated in the following sections.

3.4.2   Technology Infrastructure

Software Platform

3.4.2.1   There are two main aspects to the BEAP software architecture, including individual Built Environment Applications and the BEAP that supports them, which may be constructed in a number of ways such as:

- customizing development from scratch;
- using third party software libraries or software development kits (SDKs);
- using application services that are presented by the BEAP, or other third-party application services;
- using application functions provided by open source packages or commercial software suites; or
- a combination of the above.

Hardware Platform

3.4.2.2   The BEAP will provide a set of hosted software services that will be reside on specific servers or on cloud infrastructure, or potentially spread across both in a hybrid configuration.

3.4.3   Security Infrastructure

3.4.3.1   Security applies to all aspects of the BEAP design and operation, from the policies and procedures of the people working with the BEAP, right through to the physical security of the data centre(s) that host the BEAP.

3.5   Business Development Plan

3.5.1.1   The Business Development Plan describes the services the BEAP provides to its customers and users. It also considers the organisational aspects of the BEAP such as how it is staffed, managed, governed and funded.

3.5.2   Business Services

Built Environment Application Curation

3.5.2.1   The BEAP will maintain a catalogue of applications that are regarded as helpful in dealing with built environment issues. The curator will actively manage this catalogue - assessing, explaining, adding, and removing applications as appropriate.

Interface with Relevant Portals

3.5.2.2   As the recognised centre of excellence for built environment applications, the BEAP will be well equipped to support the CSDI for dissemination and sharing of

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

spatial data and align with the data specifications and standard developed under CSDI. Data standards ensure that data can be used interoperably such that data created within one system for one purpose can be interpreted unambiguously so that it may be used confidently elsewhere for other purposes, such as the CSDI and PSI portal (data.gov.hk).

Evaluation on Effectiveness / Performance of BEAP Applications

3.5.2.3   It is necessary to have regular evaluation on the effectiveness/performance of the BEAP applications in order to foster continuous improvements and evolution of the BEAP.

3.5.3   Governance and Operating Model

High Level Operating Model

3.5.3.1   It is recommended that the BEAP is established as a permanent corporate function of dedicated staff with relevant expertise. Other cities have demonstrated how a small team of experts can function very efficiently in delivering specialist applications and in supporting users in their adoption.

Dedicated Team for the Operation and Management of the BEAP

3.5.3.2   In order to ensure a smooth operation and management, the BEAP will require a dedicated team subject to the leadership and governance of CSDI to deliver the services and manage the platform.

End-user engagement and training framework

3.5.3.3   A key success criteria for the BEAP is likely to be uptake by users, be they internal or external. A user engagement and training framework will be required to ensure that end users can get the most out of the platform and its applications. This task should not be underestimated either in scope or importance.

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

3.6　Implementation Plan

3.6.1.1　The key implementation milestones of each building block from short to long term are summarized in **Table 3.1**:

	Short Term	**Mid to Long Term**
Overall	- Develop a BEAP in cloud environment - Implement the recommended applications as quick-win projects - Initiate an eco-system and incentives for more Government agencies, business and academia to collaborate on application development as the value of applications are being demonstrated - Set up a BEAP team to manage and lead the foundation of the BEAP - BEAP mainly for internal users (i.e. relevant B/Ds) - Directly link the BEAP to CSDI	- BEAP with an increased number of applications and supporting functions covering the areas of Planning & Landuse, Engineering & Infrastructure and Landscape, Environment and Conservation - A BEAP team continues to develop the ecosystem and drive the BEAP development - BEAP to be opened for both internal and external users - BEAP with a city-wide/cross-sectorial applications and supporting functions - Establish a mature eco-system and partnerships / engagement models with both internal (i.e. Government B/Ds) and external (i.e. business, academia, and the public, etc.) parties
Application and Actionable Data	On the basis of the recommendations of this Study to take forward the suitable applications as quick-win project in short term	- Strengthen (e.g. more functions) and widen (e.g. scale up to other regions) the applications in the area of planning and development - Develop new applications in areas covering Planning & Landuse, Engineering & Infrastructure and Landscape, Environment and Conservation

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

	Short Term	**Mid to Long Term**
	• Collaborate with B/Ds to implement planning and development related applications • Initiate preliminary applications APIs • Explore possible collaboration with the business, academia and the public	• Foster a growing community of application developers with both inter-governmental and external collaboration • Enhance preliminary applications APIs, to enable and encourage third party (business, academia and the public) to apply their ideas to develop new applications • Increase number of applications being developed and made available for the business, academia and the public • The availability and richness of application APIs gradually become more mature with more platform functionality
Technology	• Set up a BEAP Team by following the structure of the BEAP conceptual model • Provide software infrastructure, including security infrastructure sufficient to cover the applications and actionable data developed • Review supporting software packages to advise appropriate packages for the BEAP	• Implement the main phase of construction of the BEAP • Establish the core software packages and hardware infrastructures to cope with the increasing number of applications and amount of actionable data • Encourage the use of open-source software packages • Establish the security infrastructure at every level to enable different user access levels
Business and Governance	• Set up a BEAP team to manage and lead the foundation of the BEAP • Take forward high level and detailed designs/plans for the BEAP and the prioritized applications as quick-win projects	• A BEAP team continues to develop ecosystem to foster collaboration among B/Ds, business, academia and the public, as well as to drive the BEAP development • Review legal framework and establish legal basis

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

	Short Term	Mid to Long Term
	• Prepare and run tenders for implementation support, platform build, hardware, software, etc. • Liaise with CSDSC[6] and its Working Groups on matters relating to the development of the BEAP and CSDI as well as the data and technical standards to ensure alignment among each other • Interface and link up the BEAP with CSDI under the same single portal (i.e. CSDI portal)	• Develop business change strategy, including adoption, training and communication plans • Provide incentives to promote the use of the BEAP • Set out the criteria for future applications to be put under the BEAP to ensure quality of services • In parallel with work being done under CSDSC and its Working Groups, study the approach of interfacing with CSDI to ensure proper interfacing where needed • Ongoing customer engagement, extending to the business, academia and the public • With the anticipated increase in engagement with Government agencies, academia and the wider community in the development of various applications, the strength and skill requirements of BEAP team may be due for review

Table 3.1 – Key Implementation Milestones of Each Building Block from Short to Long Term

---

[6] CSDSC refers to Common Spatial Data Steering Committee co-chaired by DEVB and ITB, which is responsible to steer and oversee, with the support of the Spatial Data Office and Government B/Ds, the development and establishment of CSDI as a government-wide and territory-wide framework for spatial data management.

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

3.7   Relationship between BEAP and CSDI

3.7.1.1   Upon implementation of CSDI portal in Hong Kong, it is assumed that CSDI would become the main access route to spatial data to be shared by Government data producers. CSDI would provide a general-purpose access mechanism to incorporate spatial data and the BEAP would add value for built environment professionals by presenting a set of applications, actionable data and services that consume data from the CSDI portal. In addition, the Business Services of the BEAP will be incorporated into that of the CSDI, while the BEAP portal will be interfaced with the CSDI portal, as such, the common applications in the BEAP would be linked with and accessed through the CSDI portal.

3.7.1.2   According to, the conceptual operating model of the CSDI platform based on the recommendations of the CSDI Study[7] commissioned by DEVB (**Figure 3.3)**, it is anticipated that the BEAP would be one of a number of application platforms (or suites of applications) – as indicated on the far left of the diagram – that have been developed and shared by individual B/Ds, and which access spatial data through CSDI. The common BEAP applications and/or other B/Ds' specific business applications which are shared with other departments will have linkage to the CSDI portal, while the less common built-environment applications can be searched through the Catalogue Services under the BEAP. It is envisioned that all the required data to support the BEAP and its applications will be sourced directly from CSDI while some data collected from CSDI may need to be further modelled/processed to suit the application development. It should be noted that the data, if considered discoverable and/or sharable under the BEAP, will be fed to CSDI portal for sharing and dissemination among B/Ds or for public consumption.
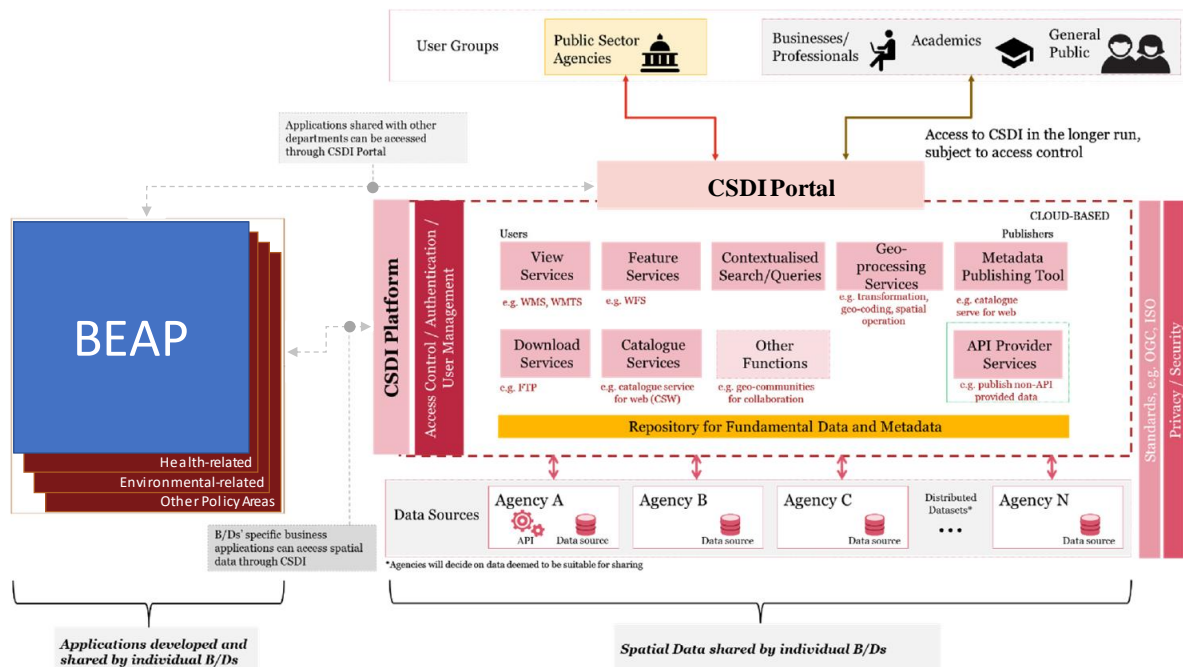

Figure 3.3 – Conceptual Operating Model of the BEAP and CSDI

---

[7]   Please refer to Figure ES4 on page 7 of the Executive Summary of Consultancy Study on Development Strategy of a Common Spatial Data Infrastructure

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

4 DEVELOPMENT OF THE PROOF OF CONCEPT AND PROTOTYPES OF THE TEST CASE FOR BEAP

4.1 30 Proof of Concepts of Test Case for BEAP

4.1.1.1 In Stage 2 of the Study, based on the potential application types identified in the Stage 1, further discussion with different B/Ds and preliminary technical reviews have been conducted to explore their potential of further development as test case. Taking into account the underlying principles including benefits to more users, user-oriented and policy-driven, scalability and data readiness, 30 application types are identified for development of PoCs, 10 out of which are selected for further development as prototype applications.

4.1.1.2 A list of 30 PoCs under different thematic areas (i.e. (i) Planning and Landuse; (ii) Infrastructure and Engineering; (iii) Landscape, Environment and Conservation; (iv) Others), in which 10 are identified as prototypes under the Study are shown below:

Planning and Landuse
(1) Landuse Monitoring and Analytics*
(2) Site Search*
(3) Scenario Generation for Planning and Development*
(4) GIC Facilities and Open Space Analysis*
(5) Connectivity Analysis*
(6) Preliminary Technical Review – Traffic
(7) Preliminary Technical Review – Hazard
(8) Parametric Toolkits for Masterplan Evaluation
(9) Urban Renewal Assessment Tool
(10) Development Tool for Visualization of Government Information in AR/VR Environment
(11) e-Engagement Tool

Infrastructure and Engineering
(12) Visualization and Analysis of Underground Space and Utilities*
(13) Visualization of Existing and Planned Development and Infrastructure Projects
(14) Preliminary Technical Checking – Sewage
(15) Preliminary Technical Review – Drainage
(16) Compliance Checking of Building Plans*
(17) Work Site Inspection (Engineering)
(18) Work Site Inspection (Site Safety)
(19) 3D Visualization of Existing and Planned Developments using AR/VR

Landscape, Environment and Conservation
(20) Visualization and Analysis of Urban Green Infrastructure*
(21) Preliminary Technical Review – Noise
(22) Preliminary Technical Review – Air Quality
(23) Preliminary Technical Checking – Air Ventilation
(24) Work Site Inspection (Environmental Compliance)
(25) Assessment on Green and Blue Provision
(26) Community Resilience to Climate Change

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

<u>*Others*</u>
(27)   Built Environment Information Dashboard*
(28)   Workflow Management Platform*
(29)   Automatic Notification of Data Updating
(30)   City Management Tool

* Selected for further development of prototype applications

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

4.2   10 Prototypes of Test Case for BEAP

4.2.1.1   10 out of the 30 identified applications have been selected for further development of prototypes, where prototypes are the sample versions of the applications developed to demonstrate the capabilities and feasibility of the full implementation of each application

4.2.1.2   **Table 4.1** presents the descriptions and objectives of each prototype application. Besides, to underpin and support the implementation and operation of the BEAP, generic functions[8] in three different categories, namely visualization, data analytic and administrative have also been identified, which would be part of components of each prototype application. Demonstration sessions with over 20 B/Ds were held on 26 June and 26 July 2019 to brief the scope and key functions of each prototype and solicit their feedback.

Prototype Application	Objectives/Functions
Landuse Monitoring and Analytics	• The Government has been facing challenges on how to effectively detect land use changes from time to time to identify possible illegal activities and unauthorized development. The application is an integrated platform for stockpiling multi-source, -level and -date images, which can be accessed and visualized by users, as well as facilitating land use classification and detection of land cover change with the aid of AI technology. • The application adopts the integrated approach for collecting image data from 'space', 'sky' and 'land', which are referred to satellite images, aerial photographs, images captured by UAVs, site photos and scanned images taken by moving vehicles, to enhance the accuracy of the methodology in undertaking land use classification and detection of land cover/height level change.
Site Search	• During planning and design stage of developments, B/Ds often have to undergo an initial screening exercise to identify the potential suitable sites to meet their specific purpose based on pre-defined searching criteria. Under current practice, PlanD would initiate the site search exercise upon the B/Ds' request.

---

8   Visualization includes display and presentation through chart, table or dashboard and 2D/3D visualization; Data Analytics include statistical and time series analysis, Spatial analysis, Demand and Supply Analysis and Constraints and Opportunities Analysis and AI recommendation and computing; and Administrative include Retrieval of both graphic and textual spatial information and Export findings and results to different formats.

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

	• The application aims to revamp the existing site search tool with incorporation of advanced GIS technology and additional criteria to enhance the efficiency and accuracy of the searching results, and to provide a one-stop web-based platform to facilitate B/Ds to submit site search requests.
	• Key functions include developing a web-based platform for B/Ds to input required site parameters and submit site search requests to PlanD; performing suitability analysis to find out the suitable site of different locations for accommodating specific land use by factoring in various selection criteria; visualizing site search results via an interactive GIS platform in 2D/3D environment; retrieving the current and previous site search records for comparison and prioritizing results with weighting of different searching criteria.
Scenario Generation for Planning and Development	• To facilitate land use planning, a scenario generation tool is developed that allows users to generate a preliminary landuse scheme (with building massing) in 3D environment for NDAs or a particular area based on the pre-defined development parameters.
	• The application embraces functions to modify the development schemes and visualize the instant results upon alteration in development parameters such as plot ratio, number of building blocks or floors, etc. and to conduct compliance checking of the proposed schemes against relevant planning and building guidelines/regulations.
GIC Facilities and Open Space Analysis	• The provision of GIC facilities and open space is based on various factors. Hong Kong Planning Standard and Guidelines (HKPSG) has set out a criteria for determining the scale, location and site requirements of various land uses and facilities.
	• The application provides a tool to easily assess the provision requirements of GIC facilities and open space at district or New Development Area and to visualize spatial distributions of community facilities and open space via the web-based map interface.
	• Key functions include generating a summary of table showing the existing and planned various GIC facilities and open space based on the input of the population projection in an area and the provision requirements as stipulated in the HKPSG, displaying spatial location of GIC facilities and open space with supplementary detailed information, and conducting service area analysis of GIC facilities and open space, which provides an overview of the extent of services coverage of the facilities and open spaces to facilitate decision-making in particular for planning of new GIC facilities and open spaces.

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

Connectivity Analysis	• The importance of pedestrian-oriented development has been well recognized by the Government in improving and reinforcing city attractiveness and citizen well-being. • The application provides a common platform to display the pedestrian network connection and associated facilities in 2D/3D environment, conduct walkability analysis to enhance the pedestrian environment and land use planning, and to encourage sharing practices and research results from the academia or other organizations to promote walkability in the community.
Visualization and Analysis of Underground Space and Utilities	• Hong Kong has encountered land supply shortage problems for years and thus making good use of underground space could help relieve the pressure of land supply. • The application integrates relevant information to produce an interactive 3D underground space and utilities platform that visualizes the existing underground space development, structure and utility network, etc., to assist the Government B/Ds in underground space planning through identification and visualization of various possible constraints, and to facilitate underground utilities planning and checking.
Compliance Checking of Building Plans	• Throughout the whole building design and construction process, extensive effort and resources are often required to conduct checking of various building plans against relevant guidelines/regulations. • To promote the wider and fuller use of BIM technology that is a key lever to accelerate the productivity in the building and construction sector, the application provides functions to help extract the required information from BIM projects to facilitate compliance checking against the prevailing regulations such as statutory planning restrictions, fire safety, etc. in the course of the vetting process of building plan submissions, thus saving time and resources for tedious manual checking.
Visualization and Analysis of Urban Green Infrastructure	• In a high-rise and compact city like Hong Kong, the green and blue assets[9] would be the essential components to make our city become livable and sustainable. To take forward the development of functional green infrastructures in Hong Kong, the application is tasked to provide a web-based common platform for visualizing green-related information, academic research results of green-related indices

---

[9] Green and blue assets generally refer to urban infrastructure relating to vegetation and water.

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

	• with a view to supplementing more information to facilitate making informed decision in the course of built environment planning. • Key functions include collecting and collating different green/blue data in urban area from various sources; visualizing green-related information and academic research results of green-related indices which would serve as reference or supplementary materials in the course of built environment planning and performing shadow analysis to allow users to calculate the shadow ratio of a selected area to facilitate local/district planning.
Built Environment Information Dashboard	• Although some Government websites, such as the GeoInfo Map, Hong Kong GeoData Store and MyGovHK are available for the public to comprehend a wide range of city data, there is a lack of a dedicated platform for browsing the built environment related information, which would be of the public interest. • The application not only serves as a landing page to access to all the BEAP applications, but also provides a common platform with a map interface that displays built-environment related data and key performance indicators (KPIs) in dashboard format based on information/data gathered from the BEAs, such as the vegetation cover and the buildings with different age in district level. Through the platform, the users are also able to customize the information including the legends and the content of the KPIs to be displayed as well as to perform data analysis by selecting preferred data from a repository of the datasets, such as the relationship between building and population age.
Workflow Management Platform	• There are a number of consultancy studies commenced every year to provide expertise data/information, technical solutions, analyses, etc. to facilitate informed policy decision making. The study briefs and related tender documents of these consultancy studies are often required to be circulated among various B/Ds with professional disciplines for their input and advice and the process involved would be time-consuming and tedious. • To streamline the whole circulation process, the application provides a collaborative platform to establish workflow management for different B/Ds to tender their comments/advice on the draft study brief of the consultancy studies. Through the platform, the users are able to gain access to the previous briefs/tender documents of various projects/studies and other relevant information for reference.

Table 4.1 – Objectives/Functions of Each Prototype Application

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

4.3　Lessons Learned during Prototype Development

4.3.1.1　The lessons learned from the prototype development would be beneficial to the future establishment of the BEAP and correspond to the components of the BEAP conceptual model and its four building blocks. Details are summarised in **Table 4.2**:

Building Block	Lessons Learned
Applications Development	- Good understanding of local guidelines/regulations and their practical application - Strength of proprietary software in respect of an accelerated and cost-effective development of functions - In-depth understanding of the functions to be developed as well as their capabilities and limitations
Actionable Data for Applications Development	- The data to be consumed by the BEAP will come from a single source (i.e. CSDI) - Some data not yet in spatially enabled and machine-readable format - Lack of agreed data standards and processing guidelines - Data.gov.hk as a useful data source, but may require data reformatting and cleaning prior to adoption - Accuracy of some data to be enhanced by linking to real-time sensors, when available
Technical Infrastructure	- Need for thorough assessment of software and hardware specifications to enable full scale development of the applications - High performance hardware and network as a prerequisite for applications embedded with complex 3D operation and real-time analysis
Business Architecture and Operating Model	- License issues for each application - Differentiated access control at data and actions level - Regular review on the user requirements and application functions with B/Ds - Dedicated operator(s) for running each application

Table 4.2 – Lessons Learned during Prototype Development

4.4　Potential Linkages among BEAP Applications

4.4.1.1　One of the key objectives of the BEAP is to form an eco-system for collaboration between applications developed by various parties. In other words, each application

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

should not be in silo but potentially forming a mutually symbiotic relationship with each other so that the outputs of each application can be used by others.

4.5 Potential Linkages between BEAP and Other Systems and Platforms

4.5.1.1 Subject to the further studies, it is envisaged that there would be linkages or interface between the 10 prototype applications and the systems/platforms developed by various B/Ds or parties. As BEAP will directly rely on the CSDI for data provision, the datasets under these systems and platforms would be obtained via the CSDI.

4.6 Prototype Applications with Potential for Public Use

4.6.1.1 Among all the 10 prototype applications, taking into account the functionality, wider benefits to the users, public interests, and ease of access or operation, etc., it is recommended that the following two applications have the greatest potential for further extension for public use.

4.6.2 Visualization and Analysis of Urban Green Infrastructure

4.6.2.1 The application can be a tool for education purpose, allowing a better understanding of the effects of urban greening and providing researchers with a source of green-related data. The application also provides a platform for the students to visualize the correlation between green infrastructure with the urban environment (e.g. existing vegetation with anthropogenic heat).

4.6.2.2 The functions of the application can facilitate better landscape planning, designing planting schemes and enhancing local environmental quality through the visualization and analysis of the green-related data derived from academia or other stakeholders such as carbon absorption of trees and the local green factor. Subject to further investigation, due consideration can be given to collaborate with the academia to host this application, just like AURIN of Australia.

4.6.3 GIC Facilities and Open Space Analysis

4.6.3.1 Users can visualize the spatial distribution of GIC facilities together with their attributes to assist them in making decisions on the residence and choice of access to the public services. The application may also serve as a platform to allow exchange of ideas between the general public and relevant B/Ds.

4.6.3.2 Through the application, information on GIC facilities such as vacant school sites can be included to allow general public to contribute ideas on potential uses of the site and give opinions on the local community needs, enabling B/Ds to better design facilities tailored towards the local community.

4.6.3.3 In future, if the datasets of the GIC facilities have embraced the real-time data such as the occupancy rate of hospital beds, which would provide useful information for the general public to make better choice of community services.

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

5 RECOMMENDATIONS FOR SETTING UP A BEAP FOR HONG KONG

5.1 Implementation of BEAP

5.1.1 Overview

5.1.1.1 The implementation of the BEAP is divided into two levels of development – "Platform" and "Application", which are shown in **Figure 5.1**:
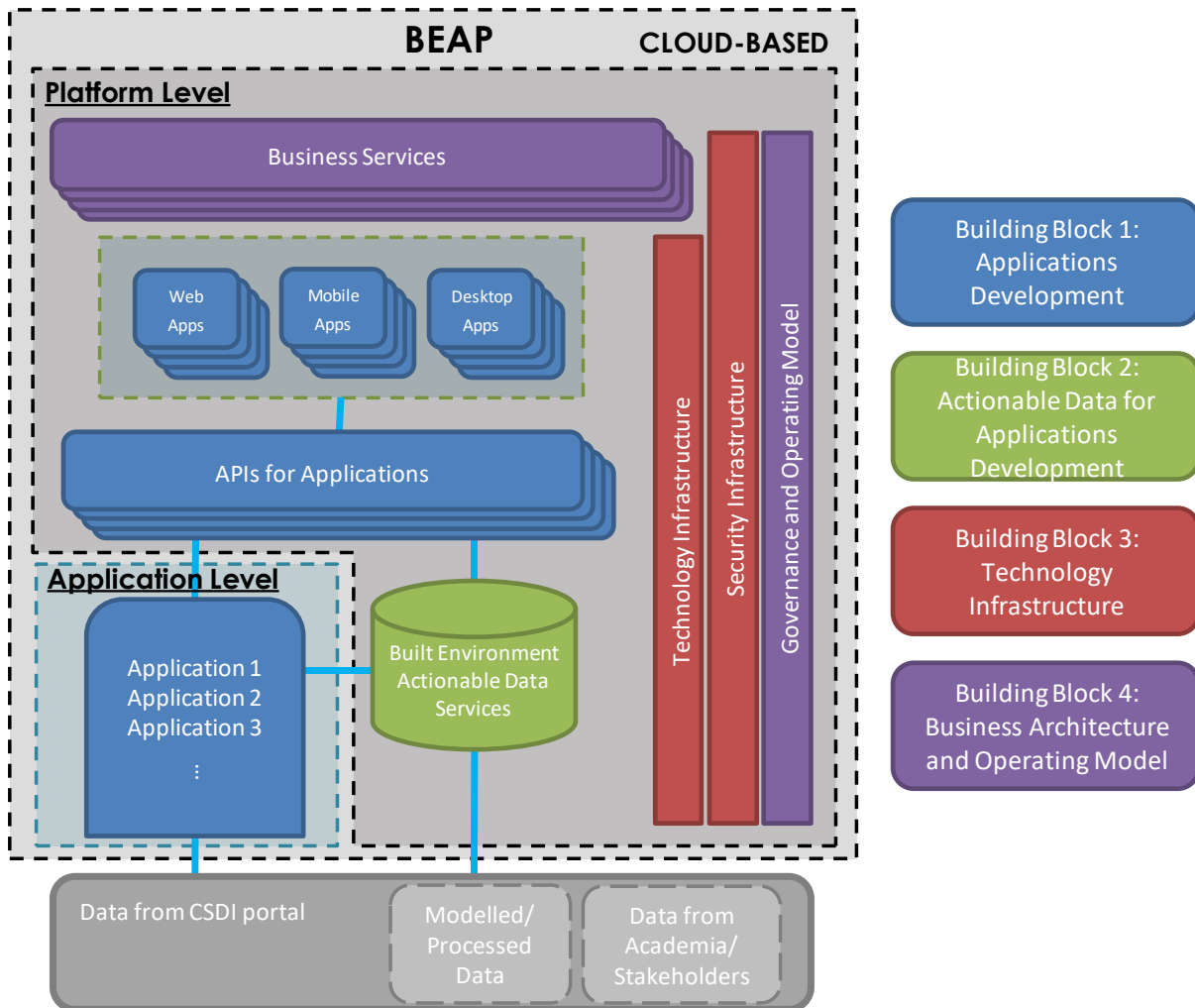

Figure 5.1 – BEAP Conceptual Model

5.1.1.2 The implementation stage for the platform development can be divided into two phases:

- Short Term (by 2022/23 tentatively) – To set up and operate an up-and-running BEAP with the development of prioritised planning and land use related applications
- Mid-Long Term – To continue developing and linking up more built-environment related applications with further scale up as well as to establish an

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

eco-system among the B/Ds and relevant stakeholders or academia for evolving application development

5.1.2 Implementation at Platform Level

Principle Design and Development Requirements

5.1.2.1 The planning, design and development at platform level for the implementation of BEAP should adhere to the following requirements:

- Be scalable, expandable, extendable, user friendly and cost effective;
- GIS and BIM oriented software as the backbone of the platform;
- Adoption of open standards to integrate with different software, plug-ins and add-on modules;
- Single management cloud platform to accommodate data and APIs from different software platforms; and
- Cross-reference to international practices and experiences.

Key User Groups of BEAP

5.1.2.2 The target users of the BEAP include internal users from B/Ds, external users from academia (including universities and research institutes) and industry users (including various relevant professional sectors), BEAP administrators who are responsible for daily system administration and maintenance of the system, as well as the public users in longer term.

Key Functions of BEAP

5.1.2.3 Among all applications, there are many functional requirements being common and similar. From the perspective of the management and operational effectiveness and efficiency, these functions could be built-in and provided at the platform to support and facilitate development of various applications, and more importantly to enhance the user experience in using data and the applications under the BEAP. These functional requirements are categorized as follows:

- System Administration
- General Query and Analysis Functionality
- 3D and Digital Twin Management
- Geo-Information Management
- Audit, Control and Security Management

5.1.2.4 Subject to the design and architecture of CSDI, if the CSDI portal can provide all the functions required by the BEAP as stated above, opportunities can be explored to integrate the BEAP into CSDI platform from resource and operation management perspectives.

Web Portal under the Platform for Applications

5.1.2.5 All applications which are common with value/benefits to multiple agencies or will be frequently used by different B/Ds would be hosted in the BEAP to facilitate browsing, query and analysis of various users. Apps approach is recommended to be adopted to facilitate organizing all applications with different levels under respective apps within the web portal for easy access. The web portal would

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

provide a single point of access (or support "single-sign-on" feature[10]) and front-end interface for users.

Data Management and Interface with CSDI and related Platforms

5.1.2.6 CSDI would become the main access route to spatial data, which would be contributed and updated regularly by B/Ds. CSDI would serve as the main data sources to support the operation of the BEAP and the applications. Thus, integrity, accuracy and updatedness of data from CSDI would affect the users' confidence in using the applications under the BEAP in delivering their tasks or meeting their business needs. In this regard, there should be better interface between CSDI and BEAP. Close liaison between BEAP team and CSDI DAWG should be maintained to avoid unnecessary duplication of works.

Interoperability

5.1.2.7 The OGCIO Interoperability Framework (IF) is primarily a collection of guidance documents, standards, and specifications that help B/Ds define the interface between interacting applications. The BEAP should comply with the latest IF (currently version 18.0)[11], and corresponding requirements from the Open Geospatial Consortium standards[12] should also be adopted.

5.1.3 Implementation at Application Level

Key Considerations for Implementation Prioritization of Applications

5.1.3.1 It may not be possible or desirable to implement all applications in one-go. To accord the priority to implement the prototype applications in the coming years under the Application Plan, the following criteria were considered:

- Application Area/Topic
- Fit with BEAP objectives
- Acceptance and ease of use
- Wider benefit
- Collaboration and support from B/Ds
- Data readiness
- Infrastructure and support

- Scalability
- Adoption of new technology
- Facilitating implementation programme of development projects
- Interdependency between applications

Implementation Phasing of Applications

5.1.3.2 Based on the above considerations, the prioritization of implementing the 10 applications are recommended as follows (**Figure 5.2**):

Short-term as Quick-win Projects (by 2022/23 tentatively)

- GIC Facilities and Open Space Analysis
- Visualization and Analysis of Urban Green Infrastructure

---

[10] Single sign-on (SSO) is an authentication service that permits a user to use one set of login credentials (e.g., name and password) to access multiple applications.

[11] https://www.ogcio.gov.hk/en/our_work/infrastructure/e_government/if/interoperability_framework.html

[12] https://www.opengeospatial.org/standards

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

- Site Search

Mid to Long-term

- Landuse Monitoring and Analytics
- Scenario Generation for Planning and Development
- Compliance Checking of Building Plans
- Visualization and Analysis of Underground Space and Utilities
- Connectivity Analysis
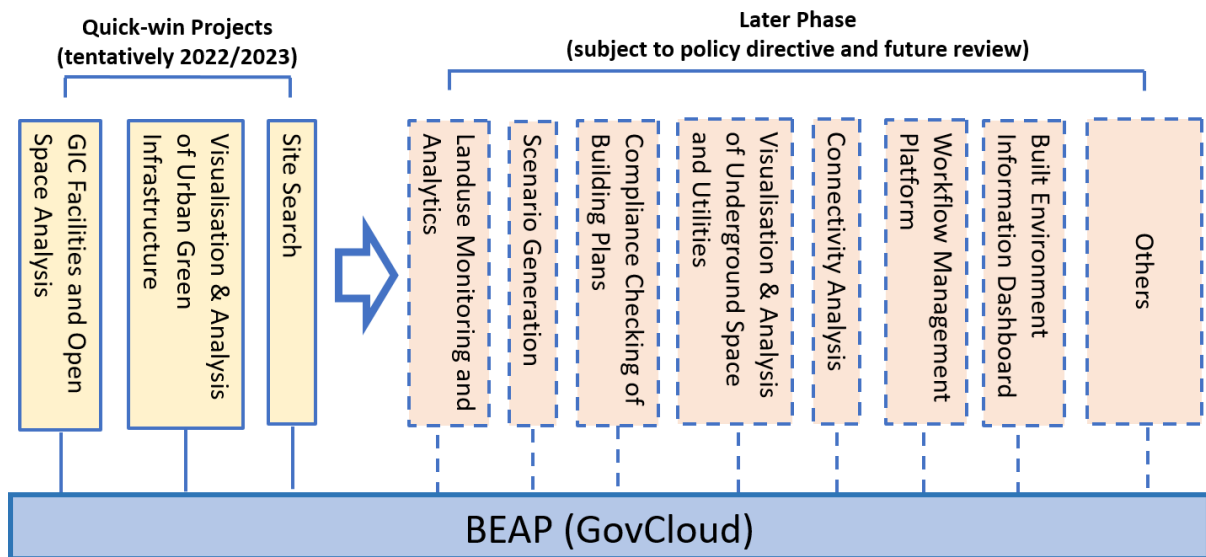- Workflow Management Platform
- Built Environment Information Dashboard

Figure 5.2 – Timeline of Application Development

Criteria for Inclusion of Future Built Environment Applications under BEAP

5.1.3.3   The success of the BEAP would depend on the collaboration, co-creation and co-sharing of various applications between different parties. The BEAP would provide a platform for all built-environment related applications shared by B/Ds or later in a wider context among the business, academia and the public. Through the BEAP, an eco-system would be created with the use of different technologies and applications such as BIM, remote sensing, data analytics, scientific modelling and other geospatial systems, where B/Ds, academia, professionals, business and different sectors of the community can co-operate, collaborate and co-create under the atmosphere, creating synergy effects and boosting up the usage and benefits of the CSDI. Therefore, when the BEAP is in place, not only B/Ds, but also the researchers from local universities and private sector should be encouraged to share their R&D results and applications via the platform.

5.1.3.4   The following criteria should be taken into account in considering whether the future applications developed by other B/Ds or parties/organisations, can be incorporated into the BEAP for shared use:

- Nature of the Application

    o   Whether the application is in line with the key themes of the BEAP

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

- o Whether the application is relevant to the overarching policy directive and the Government initiatives in promoting smart city development

- o Whether the application contributes to the improvement and upgrading of the industry

- o Whether the application opens up for more research opportunities and provides opportunities for training of local research and scientific personnel

- o Whether the target outcomes of the application would foster co-operation, collaboration and co-creation among Government, business, academia and research institutes, and attract more users in terms of quantity and diversity

- o Whether the target outcomes generated by the application would bring about wider economic and social benefits to the community

- Technical considerations

  - o Whether the application proponent and the project team would possess sufficient domain knowledge or expertise to deliver the application on the technical side

  - o Whether the application proponent and the project team have relevant previous experiences and track records

  - o Whether the application is developed based on the existing infrastructure and technology

  - o Whether the existing hardware and software infrastructure of the BEAP are sufficient to cater for the technical requirements of the application development and the future scale-up potential

- Financial and Management considerations

  - o Whether the application proponent and the project team have relevant experience for developing and maintaining the operation of the application

  - o Whether the development of the application has obtained the financial support from the relevant B/Ds or other sources such as universities, business contribution, venture capital, etc.

  - o Whether the budget, project expenditure and programme for the development of the application are reasonable and realistic

5.1.4 Technology Infrastructure and Requirements

Platform

5.1.4.1 The BEAP would be riding on the following two options of virtualized platform, which can be compared in terms of cost effectiveness, easiness of set up and management efficiency:

- *On-premise*: Ride on the upgraded hardware infrastructure in existing infrastructure of respective department (e.g. PlanD) by expanding CPU power, memory and storage to cope with increasing BEAP hardware requirements

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

- *GovCloud*: Employ the Government Cloud (GovCloud) computing services as an external resource to host the BEAP

Hardware

5.1.4.2 A multiple server architecture in cloud platform is required to accommodate different components. The following virtualized server types are recommended to support the operations of the BEAP:

- *Web server*: To host the web portal and provide communications with web clients/users through the network

- *Application server*: To host all related software and enable corresponding functionalities

- *Database server*: To store and retrieve actionable data and temporary data

- *File server*: To store all the files for users to upload and download from the BEAP

- *GPU server*: To support graphical and 3D display and visualization, as well as potential deep learning and AI functions

Software

5.1.4.3 The OS used in the BEAP must be 64-bit and supported in Virtualized Environment, as well as by the GIS and BIM oriented software. All software used in the BEAP should have flexible term license arrangement to cater for this usage pattern.

Network

5.1.4.4 The overall design principle of the BEAP network shall provide accessibility, high performance, high availability, network security and scalability. The BEAP accessibility is achieved by the web-based services orientated architecture such that authorized users may access to the BEAP and its applications any time via browsers in their workstations. B/Ds users can access and consume the BEAP services through Government network (i.e. GNET). In case B/Ds need to connect to the BEAP over external networks, they must connect to the Government network through authorized Virtual Private Network (VPN) channel first (to provide strong authentication and encryption tunnel over network connection) before accessing the BEAP. It is considered that 500Mbps is the minimum required bandwidth of GNET to support the network traffic of the BEAP while in mid/long term, with the increase in the users and the number of applications to be deployed, at least 1,000Mbps would be required to ensure smooth operation of the BEAP.

System Reliability and Resilience

5.1.4.5 In theory, system reliability is achieved by the sustainability of the service in the case of single point of failure. System architecture designed in high availability or with resilience will improve system reliability. High availability features such as redundant power supply, network cards, and hot-spare hard drives shall be specified for the BEAP to provide a stable computing environment for hosted applications.

Backup and Recovery

5.1.4.6 All the BEAP servers will be set up with appropriate system and database backup/recovery services. It is recommended that the files and data backup should

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

be performed daily. Moreover, the system should also execute full data and system backup job, which should be scheduled and performed weekly, monthly, yearly or before any changes and upgrade to system.

Data Retention and Archive

5.1.4.7   In general, the BEAP has a high frequency of data update since it generates newly dataset from various applications from time to time. Before the data is replaced by a new converted set, the previous data should be extracted and archived. At least one prior version of data should be kept for history tracking purpose.

Security and Access Control

5.1.4.8   Overall, the BEAP's security should comply with the following:

- Government's Security Regulations

- Baseline IT Security Policy

- IT Security Guidelines

- OGCIO Interoperability Framework

- Security Risk Assessment and Audit Guidelines

5.2   Operating Model and Governance

5.2.1.1   The successful experiences of many overseas cities such as Singapore and Portland, United States have demonstrated how a small team of experts can function very efficiently in delivering specialist applications and in supporting users in their adoption.

5.2.1.2   Subject to the leadership and governance of CSDI, the BEAP will require a dedicated team to steer direction of the BEAP planning and design, deliver the services, manage the platform and develop the applications to ensure a smooth operation and management of the BEAP. (**Figure 5.3**).
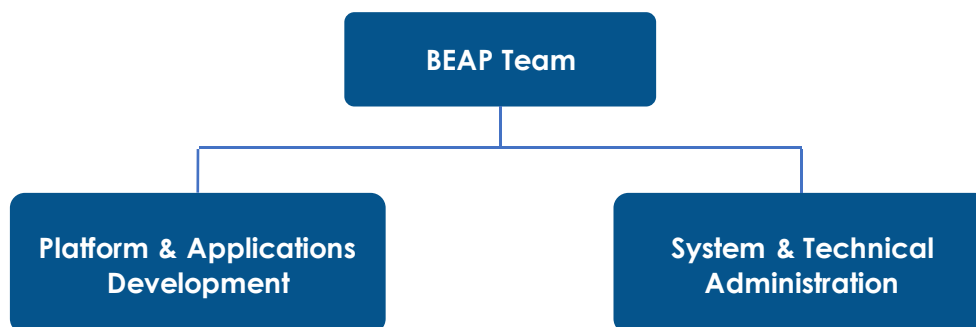

Figure 5.3 – Proposed Responsibilities of BEAP Team

5.2.1.3   It will be important for the BEAP team to manage the knowledge of how the underlying platform works and how it operates. It is considered necessary to grasp the technical understanding of how the platform is constructed in order to maintain the software and further evolve the capabilities of the platform over time. The team should also manage the technical administration such as software upgrades and backups, and the technical support of the platform such as publishing new applications and trouble shooting and resolving issues. By taking responsibility for maintaining this knowledge in-house, the team will be able to react quickly and

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

flexibly to change in demands. The BEAP team will also perform the function of knowledge succession to provide necessary support to the on-going enhancement of the BEAP.

5.2.1.4   It is further recommended that the BEAP follow a collaborative approach in which its dedicated team of domain specialists would be supported by partners from business, academia and indeed the public, who could in turn develop applications for use within the BEAP. It will be important to develop awareness of the BEAP among the relevant communities and to maintain communication and outreach to regularly engage users and developers, and to maintain their involvement over time.

5.3   Cost for Platform and Application Development of BEAP

5.3.1.1   Having investigated the implementation costs of the overseas case studies, the cost for the implementation of future BEAP would make reference to the funding and cost estimate of the overseas experience in conjunction with the local situation.

5.3.1.2   OGCIO is now implementing the big data analytics platform, which is targeted to be launched in 2020. This platform would provide underlying server, storage and network resources to expedite system development of e-government services and the implementation of more big data analytics projects with the adoption of big data analytics and AI technologies. Subject to further investigation, it may be possible to ride on this platform to develop the future BEAP to enable better resource utilisation.

5.3.1.3   As for the cost for development of the applications, it would very much depend on the development complexity (i.e. advancement in current technology, availability of the required software and hardware, functionality, customisation efforts, data readiness, etc.), which would be further investigated during the implementation stage.

Planning Department

Agreement No. CE 80/2017 (SP)
Development of a Common Spatial Data Infrastructure –
Built Environment Application Platform Feasibility Study
Executive Summary

6 CONCLUSION

6.1 Conclusion

6.1.1.1 The BEAP has great potential to be further developed as the collaborative platform for Government, business, academia and research institutes to foster interdepartmental and multilateral co-operation, as well as to serve as a foundation of various types of spatially and digitally enabled built environment applications for planning and design formulation, decision making, resource management, statistical analysis as well as the delivery of high quality services to the public. Through the application development, the BEAP would also enhance innovation, knowledge and value creation for different segments of the populace starting from within the Government in the years to come.

6.1.1.2 Therefore, the development of the BEAP and applications to various parties is a timely and strategically important works under the initiatives of CSDI.

6.1.1.3 It is crucial to make the BEAP available and to realize the benefits in short term along with the implementation timeline of CSDI, so as to maximize synergy, and to ensure that both platforms can be mutually beneficial to and interfaced well with each other. To secure a quick win in short term, the following are the key enabling steps and factors:

- Policy mandate and support to sustain the momentum of the BEAP development at both platform and application levels, closely after this consultancy;

- Sufficient funding that enables the BEAP to implement and to reach a state where it could demonstrate benefits and incentivises participation and collaboration; and

- An enabling institutional arrangement with a formal BEAP team that steers and drives development, procurement and review progress.

6.1.1.4 In summary, it is hoped that this Study is able to provide a strategic guideline for the continuous development of BEAP in the years to come.