IEC SRD 63320-1

Edition 1.0 2023-12

SYSTEMS REFERENCE DELIVERABLE

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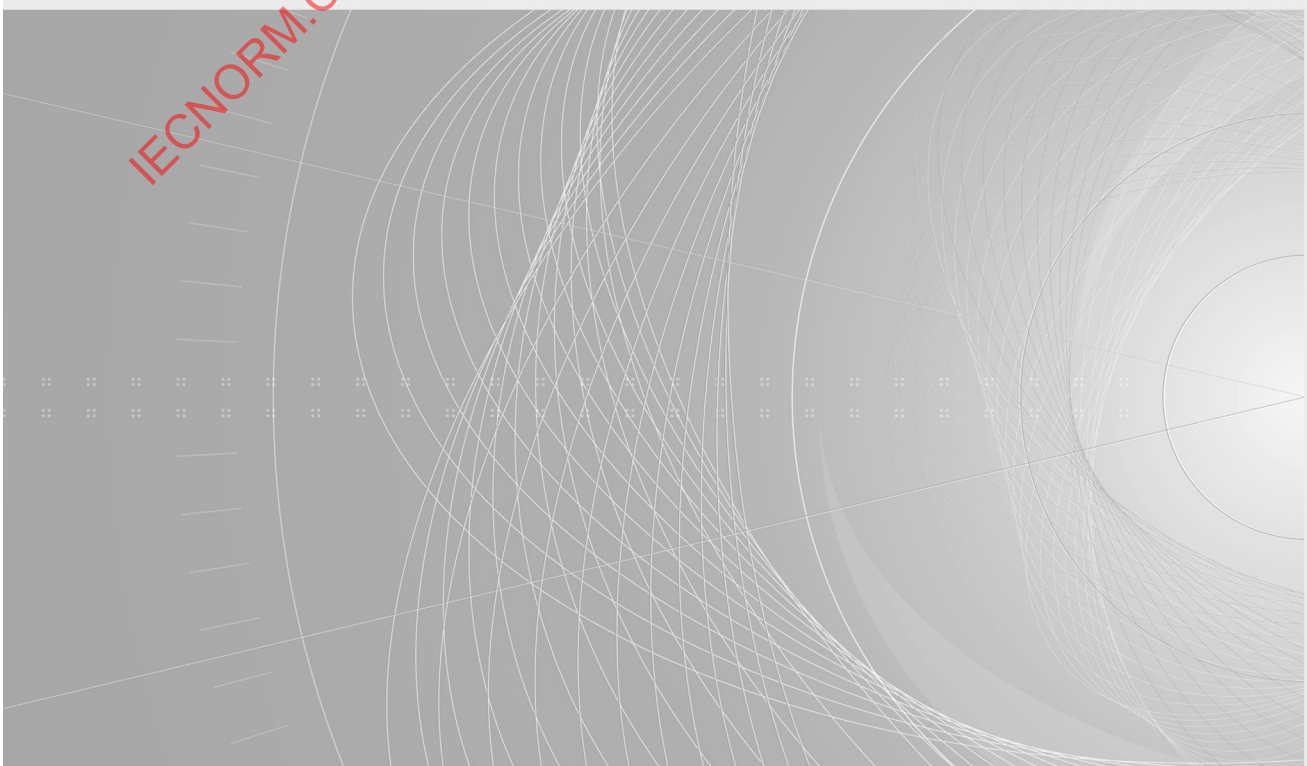
Smart city use case collection and analysis – Smart urban planning for smart cities –
Part 1: High-level analysis



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SMART CITY USE CASE COLLECTION AND ANALYSIS – SMART URBAN PLANNING FOR SMART CITIES –

Part 1: High-level analysis

FOREWORD

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IEC SRD 63320-1, which is a Systems Reference Deliverable, has been prepared by IEC systems committee Smart Cities: Electrotechnical aspects of Smart Cities.

The text of this Systems Reference Deliverable is based on the following documents:

Draft	Report on voting
SyCSmartCities/286/DTS	SyCSmartCities/301/RVDTS

Full information on the voting for the approval of this systems reference document can be found in the report on voting indicated in the above table.

The language used for the development of this Systems Reference Deliverable is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC SRD 63320 series, published under the general title *Use case collection and analysis – Smart urban planning for smart cities*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

In recent years, research on the relationship between information and communication technology (ICT) and cities, focused on imagining the future of urban planning, has been one of the most interesting topics in the industry. Smart urban planning (SUP) for smart cities is a relatively new concept and has not received much attention around the world. The “smartness” of urban planning describes the intensive use of digital technologies to optimize the urban planning process. The concept of "smart city" has been implemented and developed all over the world. In order to construct a smart city successfully, knowing how to implement SUP for smart cities is essential, because it is the foundation of smart urban construction. However, at present, reaching a consensus on the overall architecture of standards of SUP for smart cities is still challenging. The direction and user requirements of standards development is not clear, which affects the development and application effectiveness of international standards of SUP for smart cities.

Aimed at addressing the above problems, a systems approach to collect and analyse SUP for smart cities use cases is put forward. The purpose of this document is to collect SUP for smart cities use cases globally, to sort out the current situation of SUP for smart cities both domestically and internationally, including methods, framework, ideas, and GAPS model, and to analyse the needs of SUP for smart cities work and its stakeholders.

Understanding the use cases makes it easier to describe SUP for smart cities clusters and highlight use cases' commonalities. All use cases that are selected have actual legitimacy. Planning requirements are extracted from the use cases, and recommendations are given for future standardization items related to SUP for smart cities. Collecting the use cases provides SUP for smart cities to validate confirm the SUP for smart cities reference model and reference architecture.

The target users for this document include the following stakeholders who have interest in SUP for smart cities:

1) smart city planners and service providers, who can learn about SUP for smart cities needs and how to implement the ideas;
2) government agencies and heads, who can use SUP for smart cities and implement in future works;
3) citizens who want to have a better understanding of SUP for smart cities;
4) SUP for smart cities operators who need to understand the requirements;
5) regulators who are responsible for developing and managing SUP for smart cities and related regulations.

SMART CITY USE CASE COLLECTION AND ANALYSIS – SMART URBAN PLANNING FOR SMART CITIES –

Part 1: High-level analysis

1 Scope

This part of IEC SRD 63320 explains the definition, development goals and theoretical models of smart urban planning use case collection and analyses. This document identifies the key application areas of smart urban planning and determines the stakeholders and the relationships among them in the guidance of use case template.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
smart urban planning
digital and intelligent urban planning system, in which advanced technologies are used in all aspects, from decision-making, compiling, reviewing to evaluation

3.1.2
use case
specification of a set of actions performed by a system, which yields an observable result that is, typically, of value for one or more actors or other stakeholders of the system

[SOURCE: ISO/IEC 19505-2:2012, 16.3.6]

3.1.3
stakeholder
interested party
individual, group or organization that has an interest in an organization or activity

Note 1 to entry: Usually a stakeholder can affect or is affected by the organization or the activity.

[SOURCE: IEC 62542:2013, 3.19, modified – "interested party" has been added as a preferred term and the corresponding note to entry deleted.]

3.1.4
domain
area of knowledge or activity characterized by a set of concepts and terminology understood by the practitioners in that area.

EXAMPLE Taken from Smart Grid/energy system area: Generation, transmission, distribution, customer.

Note 1 to entry: Major area of similar technologies and organizational background, for the energy system some domains are suggested in this document as examples throughout this document.

[SOURCE: ISO/IEC 19501:2005, Glossary]

3.1.5
functional requirement
requirement that describes what the system must do

Note 1 to entry: They are actions in response to events, or actions performed autonomously. They represent operations and features provided.

[SOURCE: IEC TR 62559-1:2019, 3.13]

3.1.6
non-functional requirement
requirement that describes what qualities the system must contain from an execution and performance perspective

Note 1 to entry: These are also known as “constraints”, “behaviour”, “criteria”, “performance targets”, etc. They set limits or controls on how well the system performs the functional requirements.

Note 2 to entry: Non-functional requirements include: reliability.

[SOURCE: IEC TR 62559-1:2019, 3.14]

3.2 Abbreviated terms

SUP	smart urban planning
ICT	information and communication technology
AI	artificial intelligence
CIM	Common Information Model
IoT	Internet of Things
LPWAN	low-power WAN
VR	virtual reality
SDG	Sustainable Development Goal
GIS	geographic information system

4 Contributing to Sustainable Development Goals

4.1 General

The United Nations published 17 Sustainable Development Goals (SDGs) with an aim to enhance world peace and prosperity, eradicate hunger and poverty, and protect people and the planet by 2030. It calls for innovation and broad collaboration between public and private society. The IEC SRD 63320 series mainly addresses Sustainable Development Goal 11 (Goal 11): sustainable cities and communities.

4.2 Application area of smart urban planning

Goal 11 aims to make cities inclusive, safe, resilient and sustainable. This goal includes 11 targets which are related to smart cities: 11.1 Safe and affordable housing; 11.2 Affordable, accessible and sustainable transport systems; 11.3 Inclusive and sustainable urbanization; 11.4 Protect and safeguard the world’s cultural and natural heritage; 11.5 Reduce the adverse effects of natural disasters; 11.6 Reduce the environmental impact of cities; 11.7 Provide universal access to safe inclusive green and public spaces; 11.a Strong national and regional development planning; 11.b Implement policies for inclusion, resource efficiency and disaster risk reduction; 11.c Support least developed countries in sustainable and resilient buildings.

The SUP application areas studied in this document address the full list of targets in Goal 11 (Table 1). One application domain can address more than one target. For example, the application area of smart community addresses 11.1 Safe and affordable housing, 11.3 Inclusive and sustainable urbanization, and 11.7 Provide universal access to safe inclusive green and public space.

Table 1 – Mapping application areas of smart urban planning and SDGs

SDG	SDG target	Smart urban planning application areas
11.1 Safe and affordable housing	By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums.	smart community action plan; smart land use planning; smart city security planning; smart economic planning
11.2 Affordable, accessible and sustainable transport systems	By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.	smart transportation planning
11.3 Inclusive and sustainable urbanization	By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries.	smart community action plan; smart land use planning; smart economic planning
11.4 Protect and safeguard the world's cultural and natural heritage	Strengthen efforts to protect and safeguard the world's cultural and natural heritage.	smart heritage protection planning; protection planning of historical and cultural city; smart urban cultural planning
11.5 Reduce the adverse effects of natural disasters	By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations.	smart water management planning; smart health-care planning
11.6 Reduce the environmental impact of cities	By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.	smart environmental protection planning
11.7 Provide universal access to safe inclusive green and public spaces	By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities.	smart community action planning; smart ecology management planning; smart urban environmental protection planning
11.a Strong national and regional development planning	Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning.	smart government services planning; smart urban master planning
11.b Implement policies for inclusion, resource efficiency and disaster risk reduction	By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels.	smart environmental monitoring
11.c Support least developed countries in sustainable and resilient buildings	Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials.	supervision of smart architecture

5 Approach for use case collection and analysis

The IEC SRD 63320 series adopts a top-down approach to generate and collect the use case of smart urban planning, as illustrated in Figure 1.

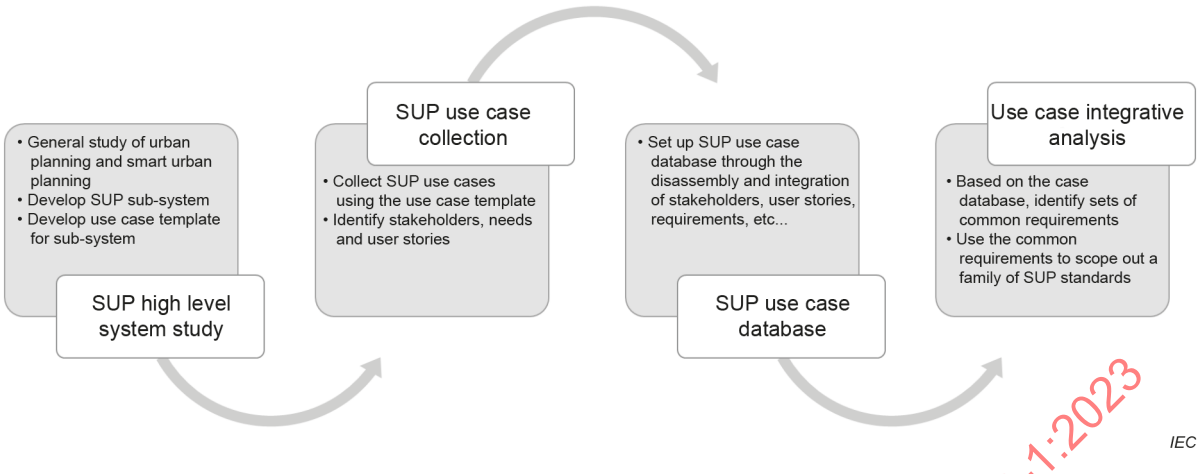


Figure 1 – Approach for use case collection and analysis

Firstly, a thorough study of smart urban planning is needed at the beginning of use case collection and analysis. The purposes of the work of SUP high-level system study include to identify sub-systems, to identify basic stakeholder needs, and to develop SUP a use case template for sub-system based on IEC TR 62559-1 and IEC 62559-2. The template of smart urban planning application area survey table is found in Annex A.

Secondly, generate and collect a list of use case about smart urban planning following the use case template. Develop a list of significant user stories based on the collected use case. In each corresponding area, one user story is generated for one specific stakeholder. Each user story follows the same template, which includes one stakeholder (as a specific type of user), a specific situation (when), a goal (I want to), and a reason (so that).

Thirdly, break down each element of the use case, including stakeholders, user stories, etc., and establish the use case database of smart urban planning.

Lastly, conduct an integrative analysis based on the use case database, and identify the standard gaps for smart urban planning and requirements for a family of smart urban planning standards.

This document focuses on the first and second steps of the work approach.

6 Use case stratification

6.1 General

IEC TR 62559-1 and IEC 62559-2 give a detailed definition and classification about business case, high-level use case and specialized use case. The IEC SRD 63320 series will consider the content and stratification of smart urban planning to correspond to three levels of use case.

6.2 Business case

A business case comes into being when something unites different actors (stakeholders) with their own business goals.

For smart urban planning, business cases can be identified according to the step of urban planning. There is a total of six business cases in smart urban planning, corresponding to the six steps of urban planning system, namely preparatory work, data collection and analysis, strategy formulation, plan review and approval, plan implementation, and monitoring and assessment.

6.3 High-level use case

High-level use case describes a general requirement, idea or concept independently from a specific technical realization like an architectural solution. High-level use cases can be derived from business cases through model transformation, in which business actors involved in business cases are transformed into logical actors that are interpreted as logical entities involved in a particular high-level use case.

For smart urban planning, the application area of smart urban planning is regarded as the high-level use case. The process of breaking down smart urban planning into different high-level use cases is a key part of high-level analysis.

6.4 Specialized use case of SUP

High-level use case usually describes an innovative, abstract function but the actual technical implementation is not dealt with. On this basis, specialized use cases can be developed and explain a tangible elaboration of the technical aspects.

7 High-level analysis of smart urban planning

7.1 General

Smart urban planning is the application of digital technology on the basis of urban planning. Therefore, model of smart urban planning is adjusted and transformed on the basis of model of urban planning.

7.2 Steps of urban planning

7.2.1 General

Urban planning is a systematic, formal, standardized work cyclic process. It includes pre-planning, planning and post-planning stages. These three stages are then further broken down into six steps, including preparatory work in the pre-planning stage, data collection and analysis, strategy formulation, and plan review and approval in the planning stage, implementation and monitoring and assessment in the post-planning stage.

1) Pre-planning stage. The first, and in some respects, the most important stage is ‘pre-planning,’ or preparing to plan. This stage diagnoses the planning area. Once local officials and the public understand the purpose, values and benefits of planning and agree on a process to prepare the plan, the following steps become much easier.
2) Planning stage. The second stage – ‘planning’ – consists of three major steps. These include data collection and analysis, strategy formulation, and plan review and approval. The planning stage in Figure 2 shows several positive feedback loops. This is meant to illustrate that planning does not always proceed in a linear fashion. At times, the planning department can need to revisit or reorder steps to respond to new data or unexpected reactions to a proposal. Some flexibility should be built into the process to accommodate these unknowns. Depending on how planners choose to organize the planning process, a given community may also have more or fewer steps than what is shown.
3) Post-planning stage. The third stage is ‘post-planning’, which consists of plan implementation, monitoring and post-implementation evaluation.

The urban planning system applies to all kinds of urban planning, including master planning, new and pre-existing land-use planning, urban revitalization, economic development planning, environmental planning, infrastructure planning, regulatory planning and so on.

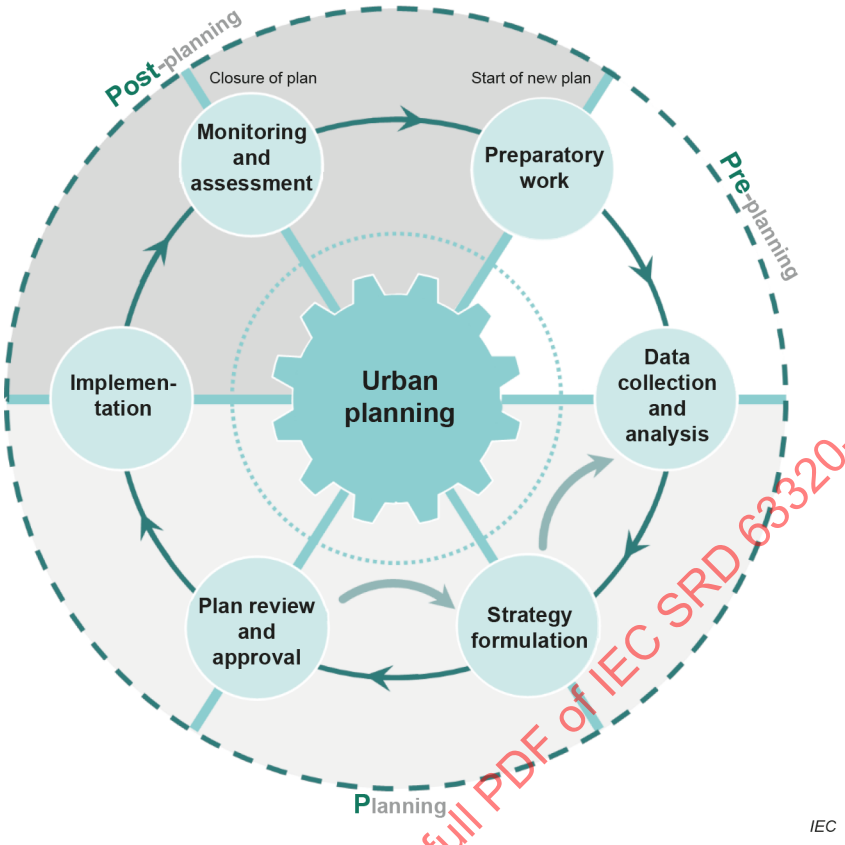


Figure 2 – The steps of urban planning

As shown in Figure 2, the steps of urban planning are a whole life cycle, from pre-planning stage to planning stage to post-planning stage, which includes six work steps. The conclusions of the last step, monitoring and assessment, usually become the basic material for a new urban planning project to start. The work achievements of each step will become the input for the next step through the arrow. In the strategy formulation step, it will return to the previous step to collect and analyse new data according to the requirements of new strategies. In the plan review and approval step, it will return to the previous step to modify the strategies if the plan review does not pass.

7.2.2 Step 1 – Preparatory work

The goals of preparatory work of urban planning are to identify the planning problems and objectives, available resources within the planning area, and stakeholders involved. The activities of this step are following.

1) Inventory existing urban planning, studies and tools.
2) Determine the planning purpose, capacity and readiness of the area.
3) Identify potential planning participants and stakeholders and agree with them on the urban planning purposes.

7.2.3 Step 2 – Data collection and analysis

Data collection uses various methods or technologies to collect city information needed by urban planning. The information collected is used for data analysis and planning compilation. Data analysis mines data value and planning suggestions from various items of urban information with the help of information analysis tools and technologies. The activities of this step are the following.

1) Urban information collection, storage and quality check.
2) Urban data analysis and interpretation.

7.2.4 Step 3 – Strategy formulation

Based on the issues reflected in data analysis and public opinion, and the development vision shared by relevant stakeholders, identify the potential planning strategies within the planning area from multiple aspects. Furthermore, this step also shall describe elements clearly involved during strategies implementation, including timeline, participants, investment fund, etc., to support the implementation of strategies. The activities of this step are the following.

1) Identify potential plan implementation strategies to satisfy goals and objectives.
2) Evaluate impacts of alternative strategies and select preferred options.
3) Recommend specific plan implementation policies, programmes, actions and tools.
4) Describe timeline and parties responsible for plan implementation.

7.2.5 Step 4 – Plan review and approval

Plan review and approval is the qualitative or quantitative review of planning results by planning decision-making departments of third-party institutions to make planning results in line with relevant policy requirements and demands of all participants. The activities of this step are the following.

1) Review the urban planning results to meet the requirements of laws, policies and published plans.
2) Present the plan for public and officials to review.
3) Make changes to the plan to resolve inconsistencies or address issues of concern to local officials and the public.
4) Take formal action to approve and publish the urban planning.

7.2.6 Step 5 – Plan implementation

Implementation supervises whether the implementation meets the planning requirements in the process of planning implementation. The activities of this step are the following.

1) Adopt a specific course of action to implement the plan.
2) Supervise the implementation of the project to meet the targets or achievements of the planning.

7.2.7 Step 6 – Monitoring and assessment

Monitoring and assessment evaluates the results of the planning implementation after the completion of implementation. It compares the gap between planning goals and actual situation. The conclusions of planning evaluation will provide a basis for new planning. The activities of this step are following.

1) Monitor progress towards achieving stated goals, objectives and indicators.
2) Review and revise plan according to schedule stated in the plan or in response to changing community needs.

7.3 Transformation of smart urban planning

Based on the steps of urban planning, the model of smart urban planning shall further interpret the planning process, activities and specific work with the help of digital and intelligent technologies.

The IEC 63320 series builds an innovative and sustainable model to drive the adoption of smart urban planning. It provides guidance for the working sequence of six critical steps of smart urban planning from preparatory work to monitoring and assessment, see Figure 3. Each step contains a number of planning activities as smart urban planning solutions supported by specific technologies, including big data, CIM, IoT, GIS, cloud, AI and so on. Specialized use case analysis shall follow such a systems model, building on the foundation of specialized use case collection.

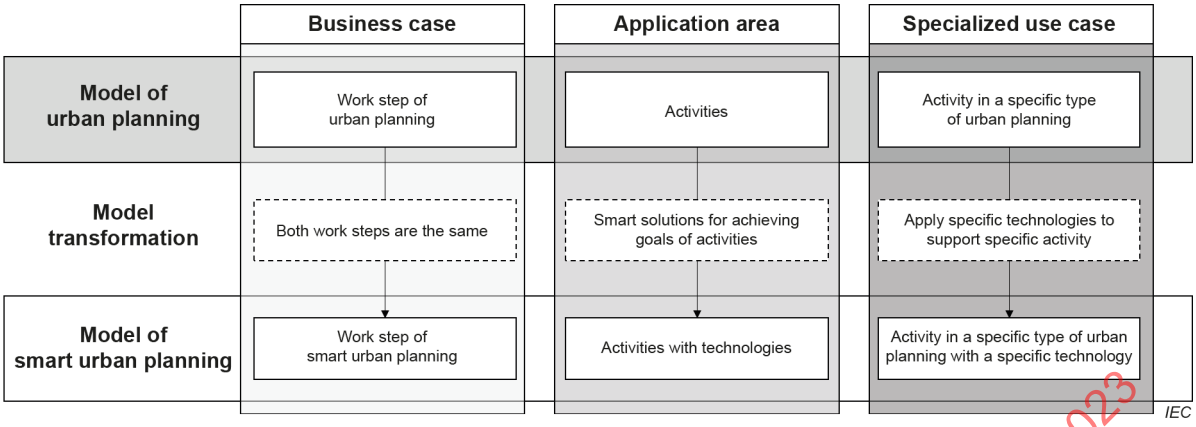


Figure 3 – The transformation of smart urban planning

8 Analysis conclusions of smart urban planning

8.1 General

Smart urban planning refers to a digital and intelligent urban planning system, in which advanced technologies are used in all aspects, from pre-planning phase to planning phase to post-planning phase. Urban planning is a complex system, involving a variety of urban planning types and complex workflow. Therefore, there are many options for digital and intelligent technologies to enhance the efficiency and effectiveness of urban planning.

8.2 Model of smart urban planning

8.2.1 General

The description of the SUP for smart cities architecture model is as follows.

Smart urban planning refers to optimizing the workflow and improving the accuracy and effectiveness of smart urban planning based on use of AI, big data, CIM, IoT, GIS, cloud and other technologies in six smart urban planning steps (business use cases), see Figure 4. Smart urban planning can help smart city planners, public sectors, regulators and others to formulate more scientific development strategies in various fields of smart cities, such as ICT infrastructure, smart transportation, smart municipality, smart community and other fields. It can help cities achieve sustainable development goals.

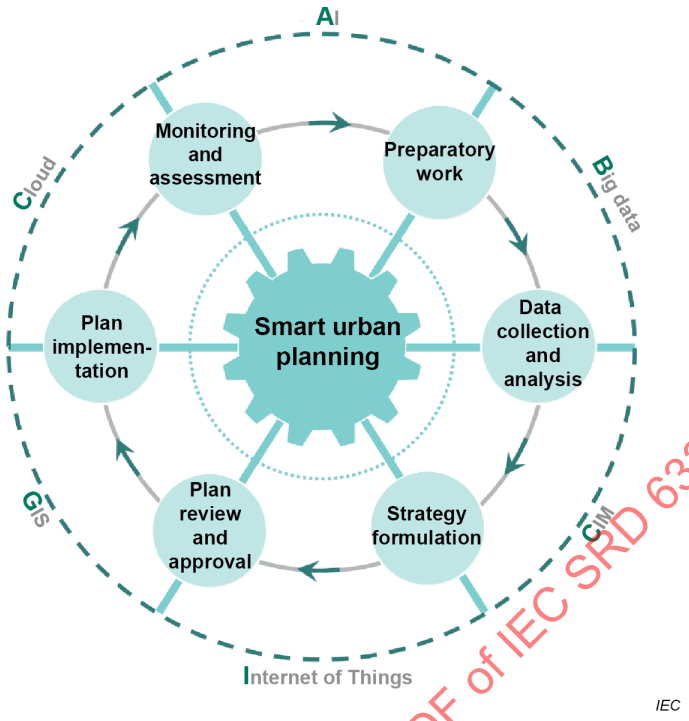


Figure 4 – The model of smart urban planning

8.2.2 Preparatory work

Preparatory work relies on the smart platform to assist planners and government agencies to organize planning tools, and try to gain recognition from more stakeholders. The technologies involved include database technology, knowledge graph technology, interactive technology and other intelligent technologies or technology packages.

The business use case of preparatory work includes two application areas: planning tool inventory and stakeholder identification, see Figure 5. The former is the most fundamental application area in the business use case of preparatory work, which aims to integrate all urban planning, studies and tools. The latter is an ensuing application area. With the support of inventory planning tools, it is easier to identify any potential stakeholders so as to set appropriate planning goals and objectives.

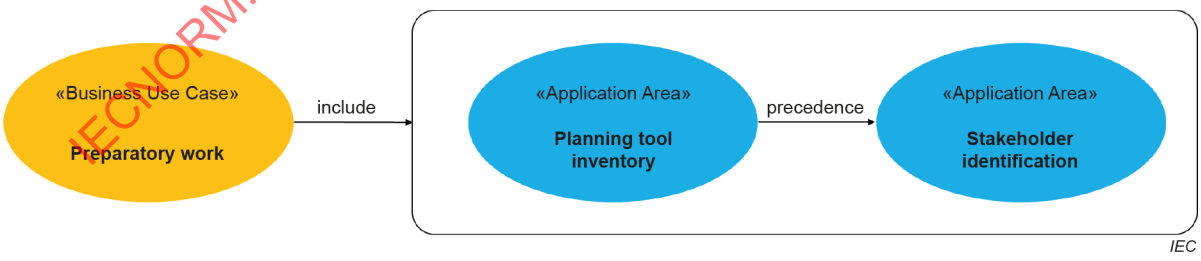


Figure 5 – General composition of preparatory work

8.2.3 Data collection and analysis

Data collection and analysis uses various methods or technologies to collect city information needed by urban planning, and to mine data value and planning suggestions from various items of urban information with the help of information analysis tools and technologies. The technologies involved include IoT, AI, GIS, CIM, big data, sensing technology, transmission technology and other intelligent technologies or technology packages.

The business use case of data collection and analysis includes two application areas: urban information collection and urban data analysis and interpretation, see Figure 6. These two application areas collect and then analyse city information in the preliminary process of smart urban planning.

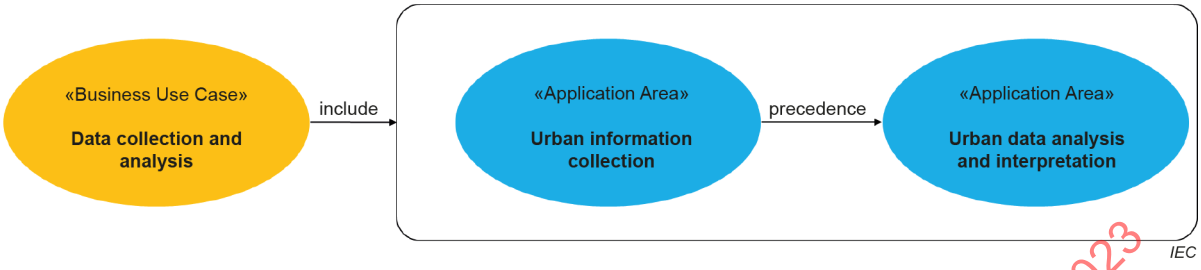


Figure 6 – General composition of data collection and analysis

8.2.4 Strategy formulation

Strategy formulation assists to improve the efficiency and quality of planning, or realize automatic planning with the help of technologies. The technologies involved include urban simulation, visual augmented design and other intelligent technologies or technology packages.

The business use case of strategy formulation includes three application areas: parametric planning, evaluate strategies and identify potential strategies, see Figure 7. The first application area is the most basic use case in the business use case of strategy formulation, which realizes digital strategy generation. Then the planning strategies are automatically assessed in the second application area. Ultimately the most reasonable strategy is identified with the support of previous parameterized planning schemes and evaluation results.

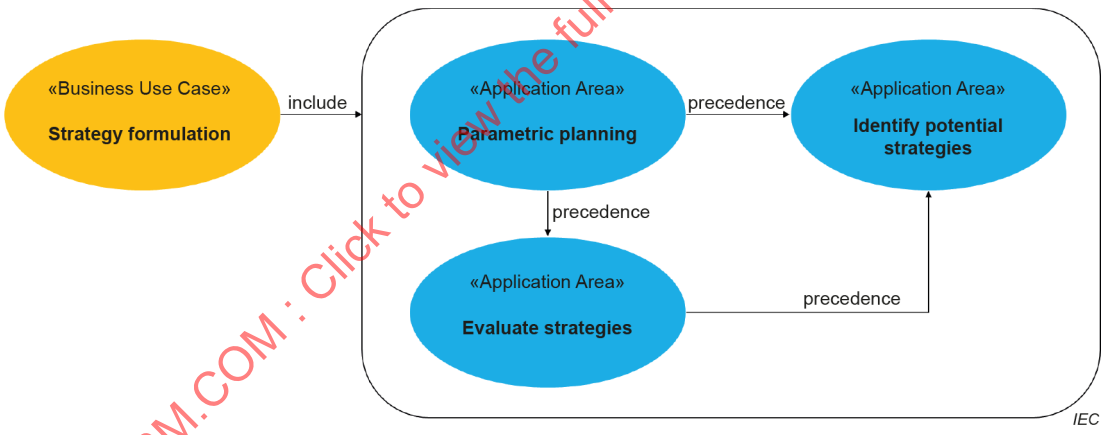


Figure 7 – General composition of strategy formulation

8.2.5 Plan review and approval

Plan review and approval is the qualitative or quantitative review of planning results by planning decision-making departments of third-party institutions to make planning results in line with relevant policy requirements. The technologies involved include spatial topology analysis, city information model and other intelligent technologies or technology packages.

The business use case of plan review and approval includes two application areas: present for review and approve and publish, see Figure 8. The former is the main application area in the business use case of plan review and approval, which aims to review projects for compliance. The latter is a subsequent application area, in which the planning is approved for construction and publicized if it meets the requirements.

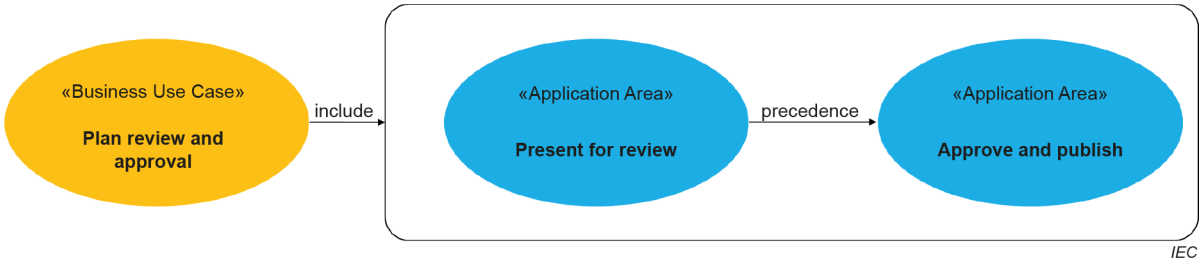


Figure 8 – General composition of plan review and approval

8.2.6 Plan implementation

Plan implementation supervises the implementation of planning requirements in the process of planning implementation based on the implementation data integration and intelligent analytics. The technologies involved include IoT, planning monitoring platform and other intelligent technologies or technology packages.

The business use case of plan implementation includes two application areas: planning conditions formulation and supervise implementation, see Figure 9. Planning conditions formulation is an important basis application area, which aims to control planning conditions to meet the requirements for the following implementation supervision.

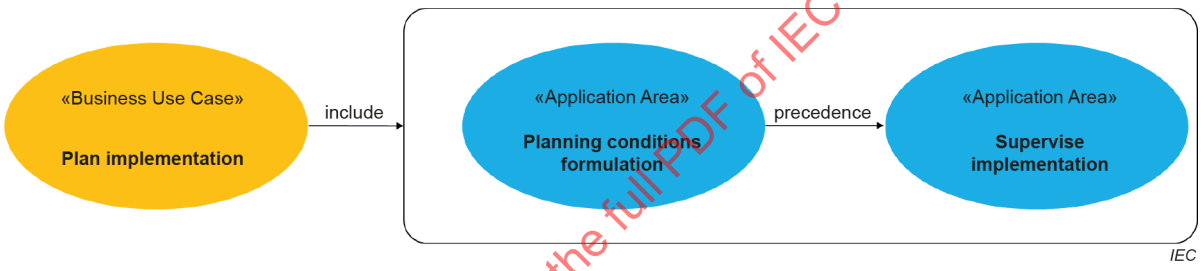


Figure 9 – General composition of plan implementation

8.2.7 Monitoring and assessment

Monitoring and assessment monitors and collect the city running data in real time, and carry on the systematic assessment for city public sectors. The technologies for planning evaluation involve urban examination platform, smart city operation centre and other intelligent technologies or technology packages.

The business use case of monitoring and assessment includes three application areas: dynamic monitoring, implementation assessment and public engagement, see Figure 10. The first application area a is fundamental scenario in the business use case of monitoring and assessment to grasp real-time urban building environment information. Then the implementation situation is automatically assessed in the second application area. In the third application area, public engagement promotes the people-oriented urban monitoring and assessment.

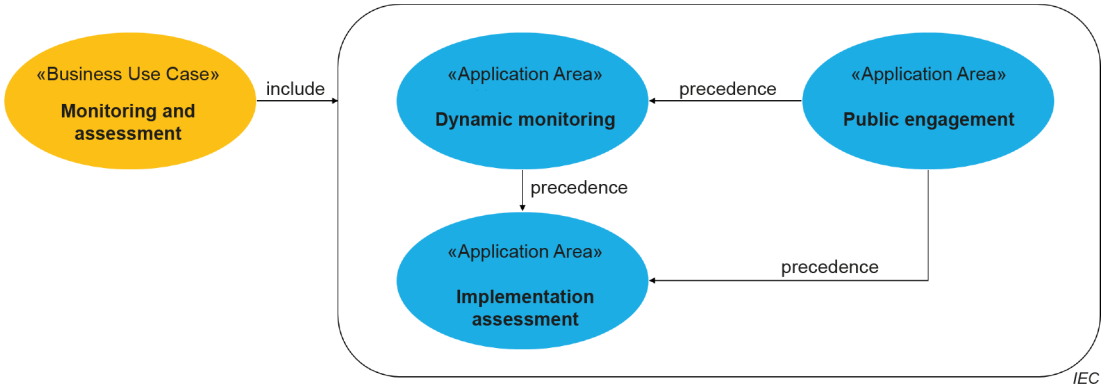


Figure 10 – General composition of monitoring and assessment

8.3 Characteristics of smart urban planning

8.3.1 Large numbers of heterogeneous urban data

A city will generate massive amounts of data during its operation, and its data sources can include traffic data, mobile data, municipal facility sensor data, economy data, etc. These massive amounts of data can effectively support the compilation of SUP for smart cities and become an important feature that distinguishes it from traditional planning. In the research of SUP for smart cities, people are able to grasp the dynamic changes of urban space and economy more intuitively and accurately by mining large data sample, real-time dynamic and micro-detailed urban planning data.

8.3.2 Analysis model based on technology

Different from traditional urban planning, which relies on empirical judgment and qualitative analysis, SUP for smart cities is based on big data and artificial intelligence (AI), which can accurately measure urban status, simulate and predict urban trends and automatically generate reference approaches through machine learning, urban quantitative analysis models and operational mechanisms. This will efficiently assist urban planners to make decisions, and greatly improve the accuracy and scientificity of SUP for smart cities research.

8.3.3 Information platform of smart urban planning for smart cities

In the SUP for smart cities, the ability to locate, transmit and share information will be rapidly improved. SUP for smart cities can accurately locate the interest groups affected by the plan through data analysis, and build information platform and discussion platform to reduce information threshold and let the public access the information and data more easily.

8.4 Technologies involved in smart urban planning

8.4.1 General

Technology has already been proven to assist in the urban planning process. Through technology, urban planning teams can increase their productivity and help citizens to get more involved in the urban design process. Some of those technologies are described in 8.4.2 to 8.4.8.

8.4.2 Cloud technology

It is a kind of data technology that collects, calculates, stores and manages massive data in a unified and standardized manner, including data collection, synchronization, data development, data quality management, data standards, data modelling and development, data security management, operation and maintenance management and other functions, so as to achieve efficient integration, unified management, sharing and exchange of city-wide data. With cloud technology, urban planners can create a database to receive details of certain urban areas. Moreover, cloud technology can help in planning larger infrastructure projects.

8.4.3 IoT technology

This technology is built based on the concept that all the desired devices can be connected inside a specific network for sharing data and information without any manual intervention. The devices used for this can be segregated conditional to their capability to send, receive and gather data in the given network. IoT is conspicuous due to its salient properties: it is secure in nature, can be used on smart devices, can connect to any type of network, aids faster connectivity, etc. Many of the basic IoT tools are already in use in an urban context. Those include smart streetlights that switch off automatically and save energy. Urban planners can build on those solutions and develop concepts that enhance the urban infrastructure.

8.4.4 AI-enabled review technology

This method is used in the planning review process. According to the purpose and requirements of the review, an automatic review system is developed to support issuing review reports, and assist the inspectors to complete format inspection, rigid index review. Standardized and objective machine review results are used to assist human review to form the final review conclusion, which serves as an important basis for project review (administrative review) and approval.

8.4.5 3D modelling technology

It applies the computer graphic technology, 3S technology – which comprises remote sensing (RS), global positioning system (GPS), and geographic information system (GIS) technology – and integrates urban two-dimensional vector data, digital image data, elevation model data, the new products of surveying and mapping data and other 3D model data. It aims to build different precision city 3D scenarios such as urban topography and landform, built environment, etc.

8.4.6 Spatial analysis technology

It refers to common spatial analysis tools, such as view analysis, sunshine analysis, thermal analysis and other spatial calculation models, which are used to analyse complex urban scenes. The basic spatial measurement and analysis functions such as distance measurement, height measurement and area measurement. The analysis results can be visually displayed with an urban 3D model.

8.4.7 Urban knowledge graph technology

It collects and processes data automatically, reduces the dimension of data into knowledge elements, and then constructs the knowledge system about the city. At the same time, the data of different urban planning knowledge fields are connected in series and parallel with the software to build a semantic network in the context of urban planning, so that it has the ability to explore, analyse and answer planning questions. In addition, the urban knowledge graph also supports advanced scenario planning functions, allowing planners to study and compare the "twin worlds" generated under different planning proposals, so as to optimize the planning scheme.

8.4.8 Virtual reality technology

Virtual reality is also helpful in simulating scenarios to model urban environments in 3D. Through the use of advanced visualization techniques, urban planners can visualize different urban areas. In this way, potential environmental impacts can be projected. This leads to better understanding of the content of planning and design in a dynamic interactive way, and improves the visualization ability of the planning scheme.

8.5 Overview of application areas collected

To arrange the business cases and high-level use cases in coherent order, an application area collection list can be derived, see Table 2. As the step of smart urban planning, each business use case contains several high-level use cases corresponding to the solutions to implement this step and forward to the next step.

Table 2 – The list of smart urban planning application areas

Steps of urban planning (business use case)	Application area
Step 1 – Preparatory work	B.1.1 Planning tool inventory
	B.1.2 Stakeholder identification
Step 2 – Data collection and analysis	B.2.1 Urban information collection
	B.2.2 Urban data analysis and interpretation
Step 3 – Strategy formulation	B.3.1 Parametric planning
	B.3.2 Strategy analysis and comparison
Step 4 – Plan review and approval	B.4.1 Present for review.
	B.4.2 Approve and publish
Step 5 – Plan implementation	B.5.1 Planning conditions formulation
	B.5.2 Supervise implementation
Step 6 – Monitoring and assessment	B.6.1 Dynamic monitoring

The detailed information collected for each smart urban planning application area is shown in Annex B.

Annex A
(normative)

Template of smart urban planning application area survey

SUP application area		
1 Basics	**1.1 Name**	
	1.2 Domain	*Which step it belongs to?*
	1.3 Author	*Name of the organization:* *Address:*
	1.4 Contact	*Name:* *Email:*
	1.5 Update Time	
2 Narrative		*Short description of the background information, goal/objective and scope of the application.*
3 Objectives		*To describe the aims or goals of the application area (mainly focus on the what the technology used in use case can solve or address)*
4 Background	**4.1 Current Practices**	*To describe the best existing exercises or operations in the specific application area without technology of smart urban planning.*
	4.2 Potential Technology	*Briefly enumerate and describe potential technologies that can be used to enhance the current situation.*
	4.3 Gaps	*To indicate the differences, especially undesirable ones, between objectives and the current practices.*

SUP application area		
5 Ecosystem	**5.1 Stakeholders**	*A person or group of people with an interest or concern in the application of smart urban planning, including name of stakeholders, role and responsibilities.* *When describing stakeholders for the specific application area of smart urban planning, the following roles are used:* • *Primary beneficiary: stakeholders which benefit directly from the solution.* • *Secondary beneficiary: stakeholders which benefit indirectly from the solution.* • *Tertiary beneficiary: stakeholders which benefit indirectly from the solution at one further step removed.* • *Owner: stakeholders which own/manage the solution.* • *Designer: stakeholders which can participate in designing the solution.* • *Builder: stakeholders which can participate in building the solution.* • *Maintainer: stakeholders which can participate in maintaining the solution.* • *User: stakeholders which use the solution to help meet their needs.* *There may be other roles, for instance, financer, regulator, etc. Some stakeholders will have several stakeholder roles, dependent on the application scenario being considered.*
	5.2 Relationships between the stakeholders	*To describe the connections among two or more stakeholders in the process of applying technology [draw a diagram to show relationships]* *(Simply, to describe the workflow in the application area using technology)*

<table>
<tr><td colspan="2">SUP application area</td></tr>
<tr><td>6 Scenarios</td><td>
To describe the rational actions and their relevant information (name of action, objectives, description of activity and stakeholder) for the new practice in the specific application area. [list table]
(the action could be regarded as the relationship line in workflow above)
<table>
<tr><th>Name of action</th><th>Scope</th><th>Description</th><th>Actors involved</th></tr>
<tr><td>Extract data and do exploratory analysis</td><td>Extract data from databases that meet the purpose of the analysis and do some preliminary exploratory statistical analysis.</td><td>Data technicians are responsible for helping the planner or researcher to extract and sort data. With the extracted data, Data technicians should help the planner or researcher to do exploratory statistical data analysis to find problems or potential patterns…</td><td>Planner/Researcher, Data Technician, Database</td></tr>
</table>
</td></tr>
<tr><td>7 Requirements</td><td>To summarize the requirements in the process of applying the technology of smart urban planning, including the function, user, data, laws and regulation, standards, life cycle consideration and others.</td></tr>
<tr><td>8 General remarks if any</td><td>Any key issue not mentioned above. For instance, listing any important existing standards that are widely used.</td></tr>
<tr><td>9 Special use case if any</td><td></td></tr>
</table>

Annex B
(normative)

Description of smart urban planning application area

B.1 Preparatory work

B.1.1 Planning tool inventory

SUP application area		
1 Basics	**1.1 Name**	Planning tools inventory
	1.2 Domain	Preparatory work
2 Narrative		This application area is based on is a multi-platform geospatial urban planning analytics system integrating data from various sources. It enables advanced spatial visualization and analytics for planners to easily access and analyse various land-use planning information that promotes the centralization of urban information, analysis methods, communication channels, information publication and other tools needed for urban planning. The collaboration platform is the key to construction of smart city and the basic support for the pre-process of urban planning. It can realize the integration and sharing of various information services including government data, industry data or private sources, provide dedicated analysis tools needed for planning strategies, and enable urban planning publicity, enquiry, information release and information feedback from the public. With quick access to such information, planners are better equipped to anticipate changes and coordinate better with relevant agencies to facilitate integrated planning.

3 Objectives		a) Realize centralized storage, streamlined management, digitalized display of spatial data, department data urban sensing data and so on, and provide convenient data query and download function for users. b) Converge technologies such as integration of spatial analysis and modelling tools to effectively take advantage and mine value of vast urban data. c) Provide information publication and communication channels to release urban information or enquiry functions in the form of services, and promote the linkage of information, organization and work content within various government departments, as well as among other stakeholders.
4 Background	**4.1 Current Practices**	Most urban planners and researchers usually search for and download urban information, especially geographic data, in map platforms, and public information in the government portals, or go to the planning department for non-public paper materials enquiry. Then they process these data through different technologies such as GIS and modelling software.
	4.2 Potential Technology	Cloud technology. With cloud technology, urban planners can create a database to receive details of certain urban areas. Moreover, cloud technology can help in planning larger infrastructure projects. Analysis technology. It refers to WebGIS, spatial analysis tools and other technical algorithm carriers that provide services concerning spatial analysis on the website platform. Interactive technology. It provides a common website or mobile application to publish urban information and enable information query for all citizens and technicians.
	4.3 Gaps	a) Difficult to obtain needed urban data in an effective way among different systems, different applications, and different technology platforms since the planning department is caught between "information isolated islands" where it is hard for information to flow fully. b) Difficult to ensure the reliability and feasibility of the planning decision-making based on experience. c) Difficult to motivate the public engagement in the process of urban planning because of the limited awareness and channels of public participation.

5 Ecosystem	**5.1 Stakeholders**	a) Stakeholder 1: Government departments (Platform manager) Role: Primary beneficiary, owner and user of platform for urban management and planning Responsibilities: To establish the framework and define standards for the multi-source platform construction. Provide basic urban information, social, demographic and economic statistics, as well as planning-related electronic documents. b) Stakeholder 2: Date Engineer Role: Tertiary beneficiary and builder who participate in the platform construction Responsibilities: To organize data and establish urban multi-source data platform according to various government requirements. c) Stakeholder 3: Technical Engineer (Platform manager) Role: Tertiary beneficiary, builder and maintainer who participate in the platform construction and solve any technical problems in the platform. Responsibilities: To organize data and establish urban multi-source data platform according to various government requirements. d) Stakeholder 4: Platform Role: Tertiary beneficiary Responsibilities: To integrate and store urban information, converge technical tools for urban analysis, and enable information enquiry for users. e) Stakeholder 5: Planning Institute/Planner Role: Primary beneficiary and user who can search and obtain urban information in platform Responsibilities: To understand the current urban situation, to develop short- and long-term master and specialized schemes to create, grow, and revitalize areas in cities. To give the guidance to stakeholders during city planning. f) Stakeholder 6: Citizens (data providers) Role: Primary beneficiary and user who can search and obtain urban information in platform Responsibilities: They are a source of data as they can provide information on what they are and what they need in the process of urban planning.

	5.2 Relationships between the stakeholders	The relationships between the stakeholders in planning tool inventory are as shown in Figure B.1.

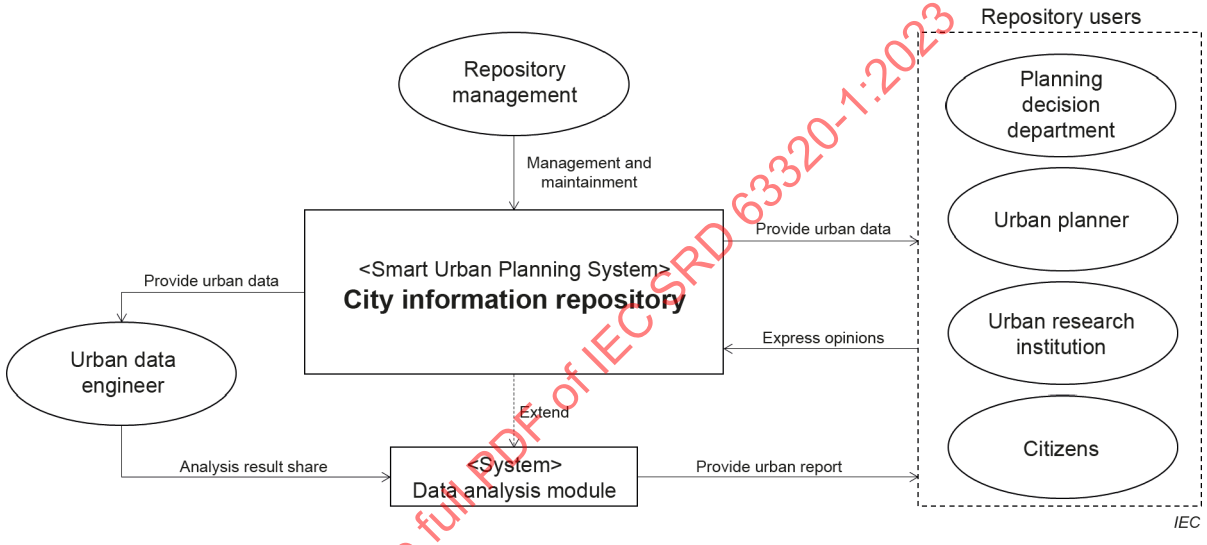


Figure B.1 – Stakeholders of relationships in planning tool inventory

	Name of action	Scope	Description	Actors involved
6 Scenarios	Provide governmental information and propose platform building requirements	Provide existing urban governmental and geographic data to the platform. Then the platform will build as required by government.	The urban governmental and geographic data should be integrated into a multi-source platform for data sharing. According to the requirements of government, the platform will be built.	Government department; Data engineer; Technical engineer
	Collect and organize information, and establish data platform	According to government's requirements, organize and process data, establish platform by professional engineers	Data engineer is responsible for data processing and for building urban database in the preparatory work of platform building. Technical engineer is responsible for the key techniques during the platform establishment such as cloud database, Web-GIS and web server and so on.	Data engineers; Technical engineers; Multi-source platform
	Access information	Enable the public to have access to open urban information in this platform for any purpose.	Planners and urban research institutes could use the urban data in the platform for urban planning and study work. Citizens could search, query planning information and express their opinions through website platform or mobile applications in a fast and convenient way.	Planning institutes; Citizens; Multi-source platform

7 Requirements	a) **ICT infrastructure requirements.** ICT infrastructure to support and integrate services in the process of SUP. It shall be standard, compatible and scalable. b) **Platform building techniques and legality requirements.** The building of platform requires professional computer technology such as programming and web server. And the content displayed in the platform should be legal and rational. c) **Security and privacy requirements.** The platform should avoid using personal data and any commercial data that can leak private information for illegal use and cause other security problems.
8 General remarks if any	
9 Special use case if any	Digital map, OpenStreetMap™ [1], OneMap (Singapore)

[1] OpenStreetMap™ is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of this product.

B.1.2 Stakeholder identification

SUP application area		
1 Basics	**1.1 Name**	Stakeholder identification
	1.2 Domain	Preparatory Work
2 Narrative		This application area identifies and analyses potential participants and stakeholders so as to assist planners in dealing with and coordinating their demands. Nowadays, there are a wide range of stakeholders who may contribute or influence over the planning projects. Therefore, recognizing their engagement stage and setting appropriate purposes could increase their contribution towards a common planning goal. In detail, identifying and analysing the interest of the different stakeholders is fundamental within urban planning processes. Urban planning stakeholders are groups of people and organizations that have a stake in an urban project. Stakeholder identification is either as a process or as an approach to support decision making and strategy formulation referring to development of a list of stakeholders and identifying their interests regarding urban development. It is vitally important in urban development projects to stress exactly who the participants (stakeholders) are.
3 Objectives		a) Stakeholders' interests, domain, specificity and concerns need to be identified, and the relationships, communication and conflicts between stakeholders need to be managed as well to make appropriate decisions on urban planning. b) Useful stakeholder identification methods need to be introduced to help planning project teams have a clearer idea about the structure of information among the stakeholders, and to help them identify which stakeholders or groups of stakeholders should be engaged more. c) Based on identified stakeholders, a transparent platform or channel supporting communication, collaboration and interaction needs to be established to ensure that the project team can work from a range of locations to enter information about specific engagement activities and stakeholders.

4 Background	**4.1 Current Practices**	Planners and decision makers generally identify stakeholders via a number of engagement methods, such as interviews, surveys, and workshops or focus groups. Stakeholders are usually identified by core stakeholders according to pre-defined categories, or based on the planners' experiences, as well as information in the communication practice. There are cognitive limitations of the core stakeholders. The traditional method is inefficient for stakeholder recognition because planning project participants always have to express their appeals and demands orally or in writing in the face-to-face consultative process. There are analysis models such as social network analysis model and stakeholder circle methodology used to analyse stakeholders' interrelationships. However, the accuracy of identification is likely to decrease as the complexity of the planning project increases.
	4.2 Potential Technology	a) Knowledge Graph Technology. It can integrate stakeholders' information and use a variety of intelligent analysis algorithms to assist in analysis and identification of potential stakeholders. b) Interactive Technology. It can be developed to improve the efficiency of information transmission and promote communication among different stakeholders, such as the sharing meeting platform and multi-user collaboration system. It can support digital video conferencing, visual display of urban issues with the combination of virtual reality (VR) and augmented reality (AR). Take Urban Planning Exhibition Hall at Expo' 2010 in Shanghai as an example: it applied VR system to show the stakeholders the Urban Design Guideline in the city. And stakeholders can discuss with each other about the future of the city using the virtual 3D city model.
	4.3 Gaps	a) The precise, comprehensive identification of potential stakeholders is needed. Planner's ability to identify potential stakeholders in a mass of information is limited. Some information processing methods could be applied to help them find potential stakeholders as much as possible. b) An open, transparent and participatory consultative process needs to be ensured, in which stakeholders are present in person, as well as online. These consultations must be conducted with transparency in mind along with equal access to required information. The relevant stakeholders should have prior access to the information before the consultative process starts.

5 Ecosystem	**5.1 Stakeholders**	a) Stakeholder 1: Platform Role: Tertiary beneficiary Responsibilities: Provide urban social, economic and governmental information, as well as stakeholders' attribute information. b) Stakeholder 2: Data Engineer Role: Tertiary beneficiary and builder who takes part in the solution realization Responsibilities: To mine the value of mass urban information through data cleaning and analysis. And to find out other related potential stakeholders by in-depth analysis of identified stakeholders including their interest and concerns, characteristics. c) Stakeholder 3: Customized Service Role: Tertiary beneficiary Responsibilities: Develop several specialized applications which assist planners in discovering potential stakeholders in a more convenient, precise way. Besides, it provides an open and transparent communication platform for the consultative process among stakeholders, ensuring that they can participate in and express opinions even though they are at different locations. d) Stakeholder 4: Urban Planner Role: Primary beneficiary and the user who uses the identification method. Responsibilities: it is a leader on urban planning process, responsible for identifying and giving the guidance to stakeholders. e) Stakeholders 5: Urban Planning Participants Role: Primary beneficiary and the user who has access to the communication platform. Responsibilities: it includes multiple roles especially citizens, public and private sectors, city services companies, research organizations, ICT companies and so on. They may contribute or influence over the planning projects and need consultative process to balance their demands.

	5.2 Relationships between the stakeholders	The relationships between the stakeholders in stakeholder identification are as shown in Figure B.2.

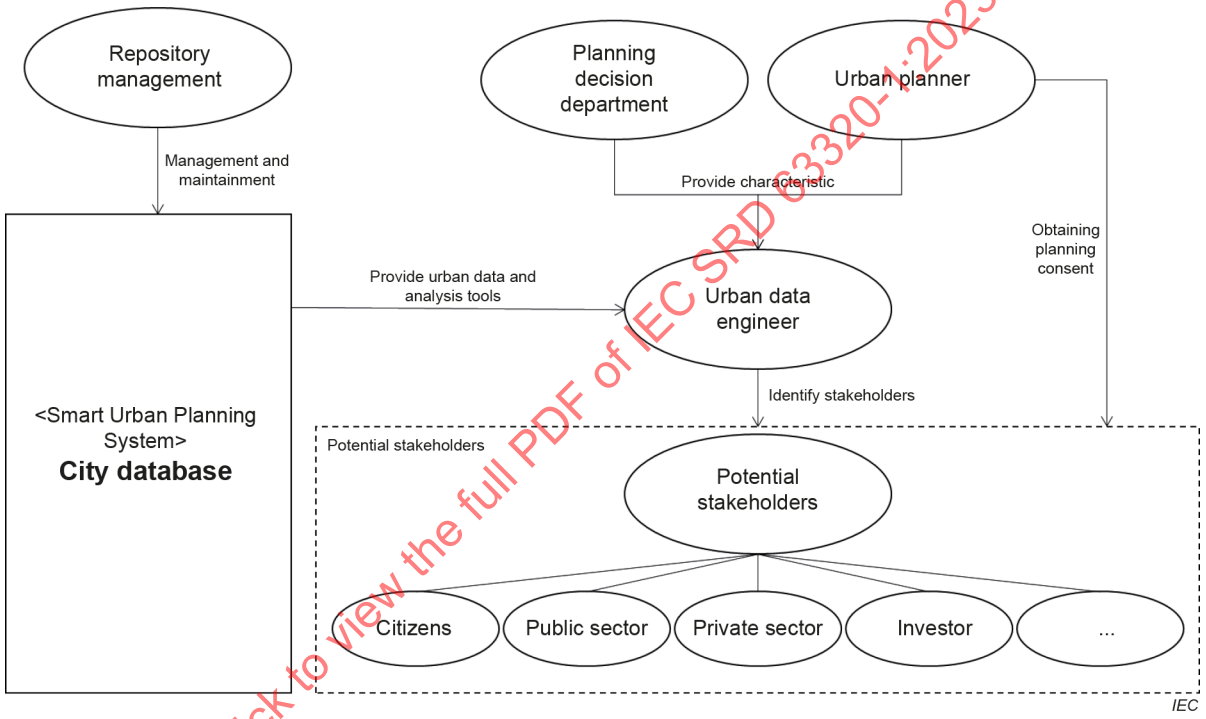


Figure B.2 – Stakeholders of relationships in stakeholder identification

	Name of action	Scope	Description	Actors involved
6 Scenarios	Collect stakeholder information	Identify the potential stakeholders more precisely, effectively.	The platform is responsible for providing comprehensive urban information for user to search and obtain.	Multi-source platform; Data engineer
	Carry out information processing	Process, clean and analyse a mass of urban data for key information mining through big data technology	Data engineers are responsible for creating a streamlined tool to transform the vast amount of urban information into knowledge graph information which is really effective.	Multi-source platform; Data engineer
	Identify potential stakeholders	Effectively identify potential stakeholders with the help of customized services including analysis technology.	According to the knowledge graph information and analysis algorithms, it could be easier for planners to comb through valuable information and find potential stakeholders.	Planner; Potential stakeholders;
	Public engagement	Provide a channel where these public participants can interact, communicate and express perspectives.	The public is a part of urban planning stakeholder. And their participation, opinion and feedback play a key in the urban planning project. Creating more channels for communication could motivate their engagement.	Citizens; Public and private sectors; City service company; Investors.

7 Requirements	a) **ICT infrastructure requirements.** ICT infrastructure to support and integrate services in the process of SUP. It has to be standard, compatible and scalable. b) **Massive amount of data requirements.** It needs a lot of urban data to support the comprehensive identification of potential stakeholders. c) **Platform building technique and legality requirements.** The building of platform requires professional computer technology such as programming and web server. And the content displayed in the platform should be legal and rational. d) **Stakeholder expertise requirements.** The planners should have enough professional knowledge and ability to guide the planning work. Other stakeholders also should be experts in their field to communicate effectively. e) **Public engagement management and regulation requirements.** The public engagement should be encouraged but not allowed without constraints. Some inappropriate comments or opinions should be prohibited to maintain a harmonious communication environment.
8 General remarks if any	
9 Special use case if any	

B.2 Data collection and analysis

B.2.1 Urban information collection

1 Basics	**1.1 Name**	Urban information collection
	1.2 Domain	Data collection and analysis
2 Narrative		This application area extensively collects, stores and cleans urban geographic data, spatial data, social data, urban planning results and other relevant information, in order to provide basis information for the subsequent analysis. Primary information, such as interview results and on-site photos, is the unprocessed information obtained directly from the events and objects to be studied. Secondary information, such as yearbooks and reports, is information that is not obtained by the researcher personally, but indirectly from others or through tools such as databases.
3 Objectives		a) Different types of primary or secondary data need to be collected, collated, stored, cleaned and invoked in order, including demographic, geographic, economic, social, transportation and other relevant data. b) Obtain primary information through field surveys, interviews with stakeholders, etc.; Obtain secondary information by contacting relevant authorities such as the government statistics department, planning bureau, land bureau, private companies, etc. c) In addition to traditional government data, relevant crowdsourcing data, Internet data, cell phone signalling, etc. also need to be collected. d) Information needs to be exchanged and shared among different departments. e) The collected data needs quality check for ensuring the authenticity and availability.

4 Background	**4.1 Current Practices**	a) In order to obtain primary information, planners generally use fieldwork methods, including in-depth interviews and questionnaires. Most studies with the perspective of economics, sociology, and public administration use fieldwork methods to obtain urban information. b) Secondary information is generally obtained from relevant authorities or companies, through technical means such as remote sensing and GIS, or through literature reviews. c) Then, those paper and electronic documents collected by planners from different stakeholders are numbered and sorted. It usually relies on planners to find value points and records from those documents.

	4.2 Potential Technology	Technology for Information Storage, Quality inspection, Fusion and Sharing: a) Database basic technology. It involves the structure, storage, design and management of database, ensuring effective organization and storage and efficient acquisition and processing. b) Data quality inspection technology. Different types of mass data are checked for quality by different means, such as graph check, attribute check, topology check, edge check, control check and logical consistency check. This could reduce the planners' working time and increase the data quality. c) Multivariate data fusion technology. It refers to the technology of integrating all the different information obtained by different means, evaluating and sorting the information in a unified way, and finally obtaining a unified information architecture. Technology for primary information collection and sensing: a) Remote sensing and GIS technology can obtain large and comprehensive information on urban spatial status such as POI, land use and vegetation. b) IoT technology can create a complex network of interconnected sensors, devices and software based on which dynamic data related to infrastructure, air quality, traffic, etc. can be continuously collected. Technology for secondary information collection and sensing: a) Big data technology can be used to search, retrieve and mine rich and high-quality data. Some big data such as social media data can be obtained by the general public through online tools, and most big data resources are mainly in government authorities, state-owned enterprises, Internet enterprises and other related enterprises.
	4.3 Gaps	Traditionally, planners mainly rely on the individuals or teams to collect, sort out and clean primary or secondary information, which would make it difficult to organize a large quantity of data and information. a) Difficult to obtain enough information from traditional government data to get a broad and intuitive picture of current planning issues. b) Difficult to find all valuable information from a large number of data obtained from different sources. c) Difficult to ensure the data quality due to complex logical relationships between data.

5 Ecosystem	**5.1 Stakeholders**	a) Stakeholder 1: planners Role: as primary beneficiary and designer. Responsibilities: they are responsible for communicating with other stakeholders and ensuring that they can provide adequate and useful electronic documents and paper materials. They are also responsible for quality check on the data collected. b) Stakeholder 2: data technician Role: as primary beneficiary and builder. Responsibilities: they use smart urban planning technologies to assist planners in completing information collection, storage and quality check. The main work of data technician includes collecting multi-source big data, constructing database, identifying and inputting all types of information collected under the guidance of planners, checking the data quality through logical relationship between data and giving feedback to planner on database status. c) Stakeholder 3: space/property owner (if any) Role: as primary beneficiary and owner of the property. Responsibilities: owner owns the building, land, or other immovable property. Planning will directly affect the property that the owner owns. During the information gathering phase, the owner primarily provides information and data related to their property and provides recommendations to the planner. d) Stakeholder 4: planning decision maker Role: as primary beneficiary and owner of planning Responsibilities: in the information collection phase, government or the planning owner helps planners to contact other stakeholders and collection raw materials. The owner also offers solutions to overcome the challenges to achieve the needs of different stakeholders. e) Stakeholder 5: public sectors or private companies Role: as tertiary beneficiary owning some urban data which the conservation planning needs. Urban data includes building information, urban geographic information, urban forest data, water system data and their planning documents. Responsibilities: they provide the basic data and urban planning documents which the planning needs.

		f) Stakeholders 6: citizens Role: as secondary beneficiary and the users who obtain benefit from the planning. Responsibilities: citizens living in the planning urban areas provide the raw data and suggestions for the planning. g) Stakeholders 7: information library Responsibilities: store the information collected from various sources. There is planner-led management. Its content is organized and input into a database.
	5.2 Relationships between the stakeholders	With the help of planning decision maker, the planner does surveys and collects information from different stakeholders to form material and information libraries. The data technician is responsible for obtaining multi-source big data using technology, constructing database, transforming libraries into the database through data extraction, sorting and input. In the process of data quality check, planners use data quality check techniques in database to conduct unified and standardized inspection. Data collection technologies such as remote sensing can assist planners in obtaining more information and can also replace the role of data providers to some extent. The database can assist planners in integrating multi-source data. The relationships between the stakeholders in urban information collection are as shown in Figure B.3.

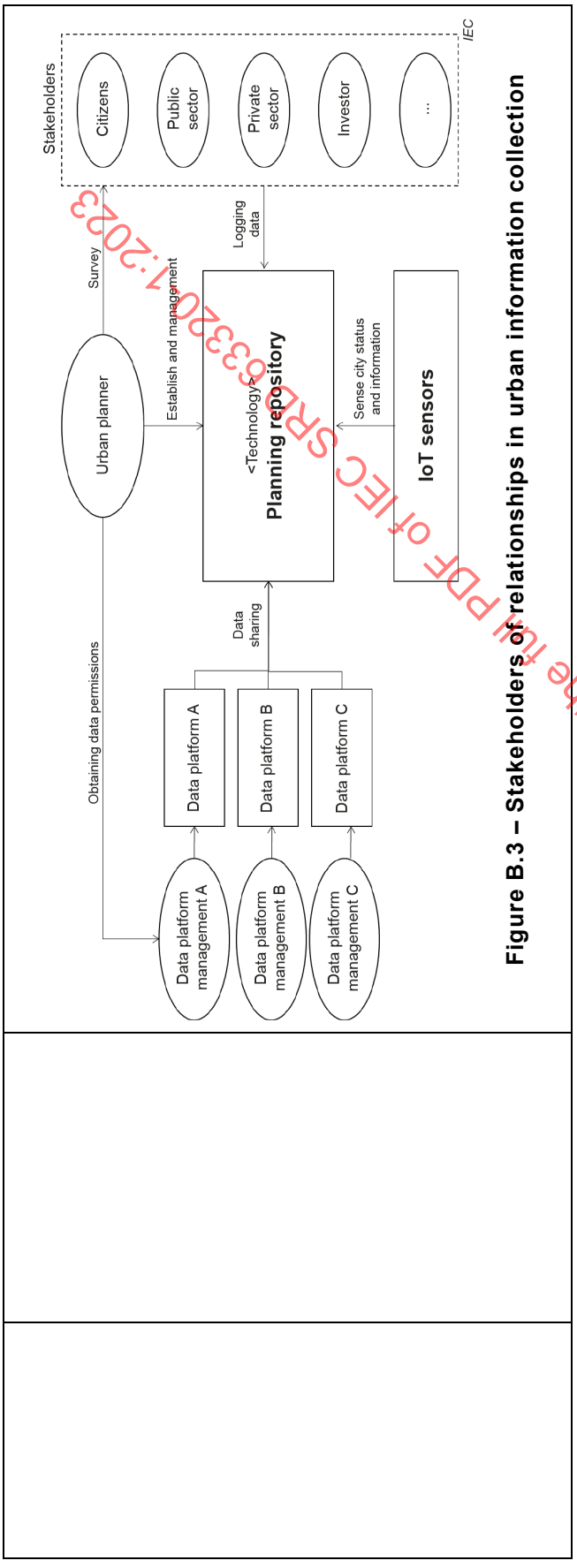


Figure B.3 – Stakeholders of relationships in urban information collection

	Name of action	Scope	Description	Actors involved
6 Scenarios	Survey, communicate and provide information	Obtain primary information through surveys and interviews with information providers. Collect secondary data by visiting the public sector, collaborating with companies, literature survey, etc.	In order to obtain information directly related to the planning project, the planner visits the project site, makes observations, conducts sample surveys or questionnaires with relevant residents or citizens, and holds interviews and symposiums when necessary. Residents or citizens provide the necessary information under the guidance of the planner. Planners are also responsible for communicating with other stakeholders, such as government departments and companies, to ensure that they can provide adequate and useful electronic documents and paper materials. Government or the planning owner helps planners to contact other stakeholders and offers solutions to overcome the challenges to achieve the needs of different stakeholders. The collected information should be stored in an information library, which is organized by the planner.	Planners Planning Decision Maker Public Sectors Private companies Space or Property Owner Citizens Information Library
	Access to multi-source information	Obtain Internet data, cellular signalling data, etc. as a supplement to data from other stakeholders, so as to	The planners specify what data is needed and communicate the requirements to the data technician. The data technician assesses the feasibility of acquiring these data and how to	Planners Data Technician RS, GIS, big data and other useful

	using technology	help planners gain a more comprehensive understanding of the current situation.	acquire them, and then retrieves, extracts and mines the requested data by using remote sensing techniques and other means. The collected information should be stored in an information library, which is organized by the planner.	technology Information Library
	Organize and store information	The valuable information is organized by filtering, cleaning and sorting. This information is then stored into database.	The planners organize the data collected from various sources, eliminate the data that do not meet requirements and retain the valuable data. Under the guidance of the planners, the data technician enters the collated data into the database.	Planners Data Technician Database and other useful technology Information Library
	Data quality check	Based on the verification and comparison between information from multiple sources, eliminate duplicate, invalid and incomplete information and form reliable, consistent and standardized information.	The planners are responsible for establishing rules for data quality checks, such as determining what data to use as ground truth, specifying which areas need to be checked, etc. The data technician is responsible for establishing an automated quality check system based on the database according to the planner's requirements.	Planners Data Technician Database

7 Requirements	a) **Regulation Requirement.** The workflow of information collection changes and the regulations need to specify the new workflow including databased construction. b) **Standard Requirement.** Urban data stored in the database require a unified data format standard and data maintenance standard, so that the data can be shared between public sectors. c) **Technical Work Requirement.** Planner should have the knowledge of database to guide the work of data technicians. In addition, data technicians as the new stakeholders are needed in urban planning. d) **Platform Requirement.** Database construction requires planning decision makers to provide hardware resources including storage and computing facilities.
8 General remarks if any	
9 Special use case if any	Singapore OneMap

B.2.2 Urban data analysis and interpretation

1 Basics	**1.1 Name**	Urban data analysis and interpretation
	1.2 Domain	Data collection and analysis
2 Narrative		Data analysis is the process of collecting, modelling, and analysing data to extract insights that support data-driven decisions to enable the government to improve its overall performance. Data interpretation is where the analyst comes up with courses of action based on the findings. In smart city planning, urban analysis is a collection of approaches, methods and procedures that aid our understanding of cities and urban life, and support our public and civic leaders in their charge to build smart, sustainable, and inclusive cities and metropolitan regions.

3 Objectives		a) Large data sets need to be processed in a short period of time. Urban data are a kind of massive amount of dynamic and static data. Therefore, they require distinct and different processing technologies compared to that of traditional storage and processing capabilities. b) The data analysis methods including linear analysis, nonlinear analysis, factor analysis, sequential analysis, linear regression, variable curve analysis, and bivariate statistics need to be leveraged for different analysis purposes. c) Data interpretation needs to be explained in an interactive and visual way to express a deeper understanding of the results.
4 Background	**4.1 Current Practices**	Traditional urban data analysis methods have limited data sources, which are generally urban statistical yearbooks or data from various government departments. The statistical time is often inconsistent, which makes it difficult to match urban data with urban spatial information. Analysing social and economic issues and patterns within cities and urban areas is by means of population census data available from national statistics bureaus or organizations Traditional urban analysis uses psychology, sociology, geography and other related disciplines to support its analysis. Most of the research pays attention to the description of urban spatial characteristics, and the degree of quantification is low.
	4.2 Potential Technology	a) Big data analysis technology. It is the technology and a software utility that are designed for analysis, processing, and describe uncovering trends, patterns, and correlations from a large set of extremely complex structures, real-time and large data sets. b) Simulation modelling and analysis technology. It imitates human learning patterns by using artificial intelligence and machine learning to model planning information and establish relationships between topics and cases. This would not only assist planners in sieving out relevant information from large volumes of data, but also allow industry stakeholders to search for planning information more efficiently. c) Multi-source heterogeneous data fusion technology. Data fusion uses mathematical methods and technical tools to synthesize different sources of information and combine complementary or redundant information in space or time.
	4.3 Gaps	Record information on dwelling characteristics, economic and demographic characteristics of the population and some, usually limited, information on daily life.

5 Ecosystem	**5.1 Stakeholders**	a) Stakeholder 1: planning decision maker Role: as primary beneficiary and owner Responsibilities: They are responsible for providing some possible status quo issues as well as potential analysis ideas and directions based on their knowledge of the city. They can also help the planner to verify the reliability of the results of the analysis. They are also responsible for understanding the current situation and problems of the city based on the data analysis and interpretation and deciding how the city could be improved in the future. b) Stakeholder 2: planner or researcher Role: as primary beneficiary and designer Responsibilities: The planner or researcher is responsible for processing data, analysing and visualizing data. After conducting the entire study, the planner or researcher should draw some conclusions and give suggestions on policymaking. c) Stakeholder 3: data technician Role: as primary beneficiary and builder Responsibilities: They are responsible for processing various urban data such as spatial data of boundaries, census data, economic data, etc. They help planners to build models, perform analysis and do data visualization. d) Stakeholder 4: database Responsibilities: Store valuable data as the basis for data analysis.
	5.2 Relationships between the stakeholders	Based on the database created upfront, the planner or researcher needs to brainstorm to think about what spatially intelligent analysis is needed, what data analysis models to build, and determine what indicators are needed. Data technicians are responsible for extracting data, building models, and implementing algorithms based on the planner's requirements. Finally, the planner or researcher provides his or her own understanding and recommendations based on the analysis results, and Planning Decision Maker determines which analysis results are relatively the most reliable based on his or her experience and decides whether to adopt the recommendations. The relationships between the stakeholders in urban data analysis and interpretation are as shown in Figure B.4.

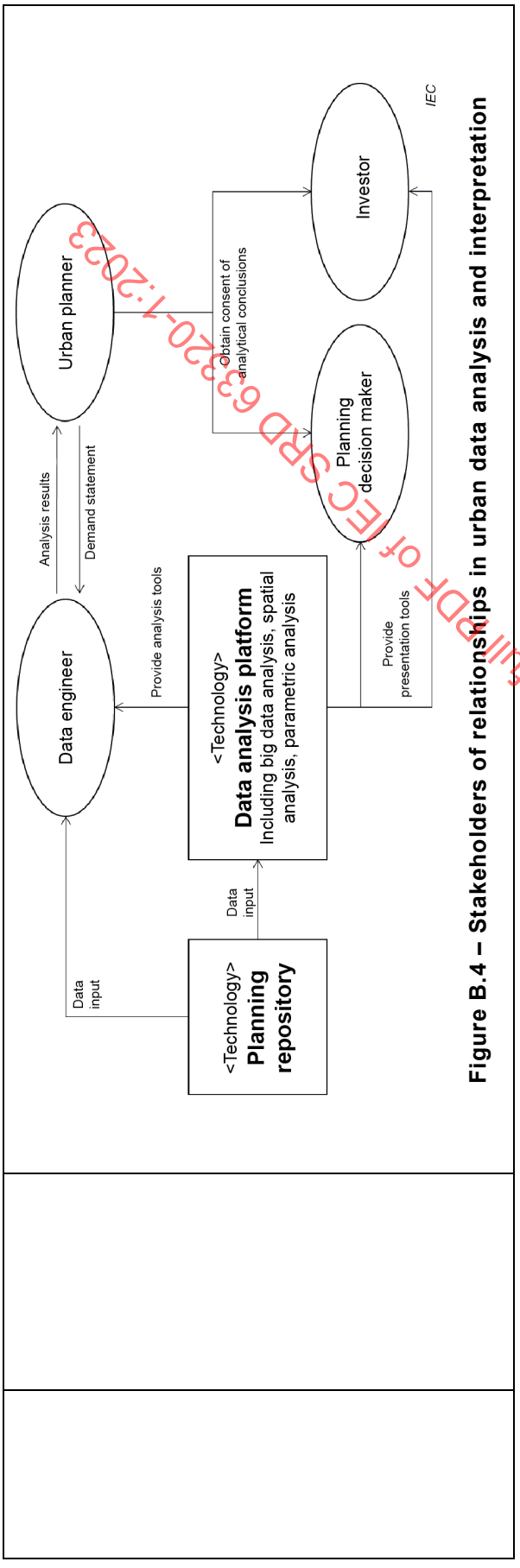


Figure B.4 – Stakeholders of relationships in urban data analysis and interpretation

	Name of action	Scope	Description	Actors involved
6 Scenarios	Extract data and do exploratory analysis	Extract data from databases that meet the purpose of the analysis and do some preliminary exploratory statistical analysis.	Based on the database created upfront, the planner or researcher needs to brainstorm to determine what indicators or models are needed. Data technicians are responsible for helping the planner or researcher to extract and sort data. With the extracted data, Data technicians should help the planner or researcher to do exploratory statistical data analysis to find problems or potential patterns. The results of these analyses need to be collected and organized.	Planner or Researcher Data Technician Database
	Build models and implement algorithms	Build data analysis models and implement the analysis algorithms to quantitatively evaluate the real-time operation status of the city from multiple perspectives.	Data technicians are responsible for implementing algorithms to achieve automated data analysis. The planner or researcher is responsible for collating and organizing the analysis results.	Planner or Researcher Data Technician Potential technologies
	Verify the reliability of data analysis and Interpretation results	Based on the professional knowledge of the planner and the planning decision maker, determine which analysis results are reliable, valuable, and can provide profound insights.	The planning decision maker helps the planner to verify the reliability of the results of the analysis based on their professional knowledge.	Planning Decision Maker Planner or Researcher

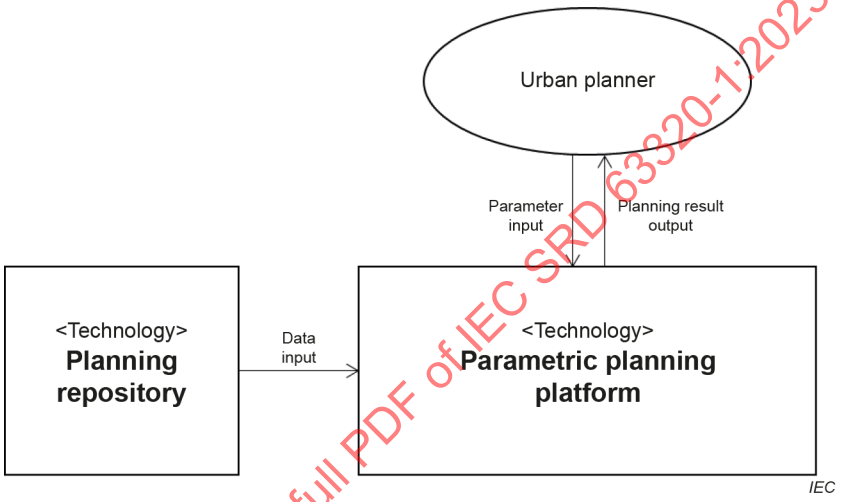
	Summarization and visualization	Summarize the results of the analysis and the corresponding planning recommendations, and visualize this information so that it can be better understood by other stakeholders.	The planner is responsible for organizing and visualizing the valuable analysis results into a logical analysis report. Planning Decision Makers are responsible for understanding the current situation and problems of the city based on the report.	Planner or Researcher Planning Decision Maker
7 Requirements	a) **Data requirements.** The data used for analysis should be representative and meet all requirements of the methods of data analysis. Moreover, the data format should be easily read and processed. And data granularity should be fine, so as to involve more information in the research. b) **Security and privacy requirements**. The study should avoid using personal data and any data that enable identification of individuals. If any data are non-public, the security of data should be specially noted during data transmission and use.			
8 General remarks if any				
9 Special use case if any				

B.3 Strategy formulation

B.3.1 Parametric planning

1 Basics	**1.1 Name**	Automated planning
	1.2 Domain	Strategy formulation
2 Narrative		Some of urban planning, such as transportation, electricity, gas, water, flood control, etc., is composed of many interrelated, interactions of elements of the organic whole, restricted and influenced by many factors, which is in constant adjustment and adaptation. As a complex integrated system, the city's diverse characteristics give automated urban planning extended platform and potential for future expansion. Automated urban design uses modelling technology, parametric algorithms and deep learning, etc. to assist urban designers or directly design in automated generation of planning scheme simply and quickly. It is a design method that combines computer and software with urban design, the characteristics of which determine its practicality and development potential in dealing with the planning and design of complex systems such as cities. As an efficient design method, it has brought a new way of thinking to planners to design the city in a more anticipatory and agile manner to meet ever-evolving needs in urban overall planning, municipal planning, road planning and other fields.
3 Objectives		a) Automated design greatly expands the idea of scheme design and saves the time and cost of design drawing making and modification. b) Flexible and adaptable site plans for evolving design contexts need to be automatically produced. c) Automated design has the characteristics of visualization and intuitiveness in artistic modelling and construction expression. d) Automated design assists urban designers or designs directly through parametric algorithms.
4 Background	**4.1 Current Practices**	Parametric technology is very mature in the field of architectural design, and it has also been explored in urban planning. Some important research institutions and architectural firms, such as The Architectural Association School of Architecture (UK), School of Architecture, Tsinghua University (China), Zaha Hadid Architects, Kokkugia Design Office, have opened a lot of projects in parametric urban design practice. For example, the One-North Project in Singapore and Kartal-Pendik Masterplan in Istanbul, Turkey have already had many applications.

	4.2 Potential Technology	a) Deep learning technology. It provides a great potential to teach a machine a human capability to design and generate city configurations, which can automate the calculation of land-use configuration and the balancing of various planning factors, so professional planners can finally adjust machine-generated plans for specific needs. b) Simulation and modelling technology. It integrates the knowledge of planning domain and generative adversarial network, and can realize the generation of urban structure and shape simply and quickly. c) Parametric modelling technology. It is a computer aided design method, including 3D visualization technology, model parameter identification and adjustment technology. Parametric modelling techniques maintain the flexibility of 3D visualization from start to finish, allowing the visual scene and parametric objects to be adjusted to each other at any time. d) Some based-on-GIS software are commonly used for parametric modelling and analysis on terrain elevation, contour, slope, sunshine and surface runoff in urban planning.
	4.3 Gaps	In the urban planning work, urban planning demands urban experts to spend considerable time and effort producing an optimal urban plan under many architectural constraints. However, to obtain effective urban plans, urban experts have to spend much time and effort analysing sophisticated planning constraints such as proximity metrics (e.g. distances to important places), access indexes (e.g. accessibility to food, recreation, goods, services, entertainment, transit, municipal services, mobility indices (e.g. sidewalks, bike lanes, speed limits, crash rates), emergency responses (e.g. hospitals, fire departments) and, thus, planning highly relies on empirical experience and domain knowledge. In the feedback and update of urban planning scheme, if urban planning parameters are modified or fail to meet the requirements of parameters, urban planners often have to remake the design results to meet the new requirements.
5 Ecosystem	**5.1 Stakeholders**	a) Stakeholder 1: urban designer Role: as primary beneficiary and designer Responsibilities: parametric model technology is used to complete the design of urban planning, so that the design results can meet the requirements of urban upper policy and related indicators. b) Stakeholder 2: parametric design platform Responsibilities: through parameter control, assisted urban designer to complete the design work, or directly generate urban design results automatically.

	5.2 Relationships between the stakeholders	Urban designers assist or automate the formation of urban planning and design results with the help of parametric design platform, see Figure B.5.  **Figure B.5 – Stakeholders of relationships in parametric planning**

6 Scenarios	**Name of action**	**Scope**	**Description**	**Actors involved**
	Parameter Input	Input urban design related control parameters	Urban designers input the relevant control indexes and design requirements into the parametric design platform in a quantitative form.	Urban designer, Parametric design platform.
	Design Output	Automatically form and output planning and design results	On the basis of parameter input, the parameter design platform automatically forms urban design results according to plot information, floor area ratio, green rate and floor height control indexes.	Parametric design platform, Urban designer.
7 Requirements	a) **Software requirements:** a mature parametric design platform supporting the specific work of urban planning. b) **User requirements:** Urban designers should be familiar with the tool of parametric design platform, and have parametric design skill.			
8 General remarks if any				
9 Special use case if any	One-North Project in Singapore Kartal-Pendik Masterplan in Istanbul, Turkey			

B.3.2 Strategy analysis and comparison

1 Basics	**1.1 Name**	Proposal analysis and comparison
	1.2 Domain	Strategy formulation
2 Narrative		Once the potential planning schemes are preliminarily developed, planners and decision makers should use smart assistants to explore the positive or negative effects of different planning schemes and evaluate planning options. It has become an increasingly dominant approach to optimize the urban sustainable development from many aspects of technical capacity, cost, environmental impact, social impact and, indeed, all aspects about the future to balance economic, social and environmental considerations.
3 Objectives		a) Systematic comparison among planning alternatives from many aspects, such as technology, capital, procurement, economic impact and social impact, is needed. b) The comparative results and presentations need to be easy to understand, so that non-professionals such as citizens, investors and governments can understand.
4 Background	**4.1 Current Practices**	Different types of planning apply simulation techniques at different times. For example, traffic simulation technology has been popular in the United States since the 1960s and is now used in many countries around the world. Urban simulation such as electric power and storm flood has been applied in many cities based on the popularity of CIM platform in the last two years
	4.2 Potential Technology	a) Simulation and modelling technology. It integrates the knowledge of planning domain and generative adversarial network, and can realize the generation of urban structure and shape simply and quickly. It can be employed to assess the impact of siting, sizing, and timing options for the planning implementation, as well as use AI models to assess different planning scenarios. In terms of economics, it can be used to calculate housing and employment capacity and economic feasibility of development at the site level so as to provide guidance on how to optimize the project. b) Virtual Reality Technology. It is helpful in simulating scenarios to model urban environments in 3D. Through the use of advanced visualization techniques, urban planners can visualize different urban schemes and compare their potential impacts. This leads to better evaluations and decisions.
	4.3 Gaps	a) The traditional way to evaluate the index is relatively limited. b) It is impossible to evaluate the overall effect of the programme comprehensively. c) The evaluation results are not vivid and intuitive enough to be understood intuitively by stakeholders.

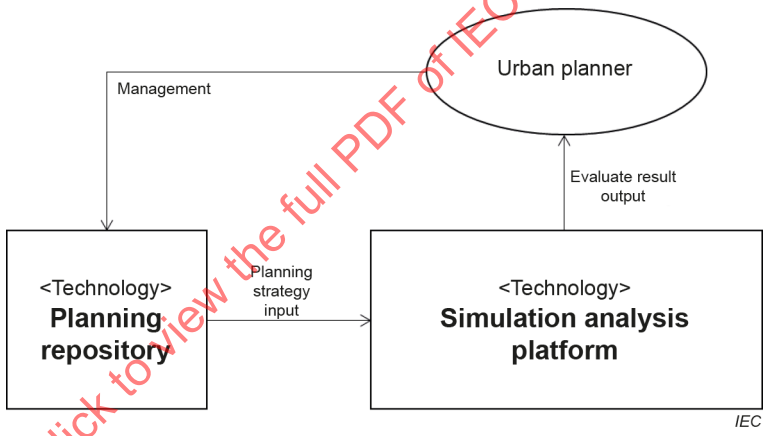
<table>
<tr><td rowspan="2">5
Ecosystem</td><td>5.1
Stakeholders</td><td>a) Stakeholder 1: Urban planner
Role: As primary beneficiary and designer
Responsibilities: Input the urban planning strategies to the simulation platform for evaluation and selection.
b) Stakeholder 2: Simulation Platform
Responsibilities: Automatic and systematic simulation evaluation of urban engineering system according to algorithm programme.</td></tr>
<tr><td>5.2
Relationships between the stakeholders</td><td>Urban planners use the simulation platform to simulate and evaluate the advantages and disadvantages of planning strategies and select the optimal scheme, see Figure B.6.
 

Figure B.6 – Stakeholders of relationships in strategy analysis and comparison</td></tr>
</table>

<table>
<tr><td>6 Scenarios</td><td colspan="3"><table>
<tr><th>Name of action</th><th>Scope</th><th>Description</th><th>Actors involved</th></tr>
<tr><td>Strategy input</td><td>Submit the completed planning strategy</td><td>Urban planners submit vector planning data that can be recognized by the platform and input relevant simulation parameters.</td><td>Urban Planner, Simulation Platform</td></tr>
<tr><td>Feedback of simulation results</td><td>Feedback the simulation results of the planning strategy</td><td>The feedback simulation results include the simulation results of engineering running state, the identification of strategic problems, and the feedback of advantages and disadvantages based on the simulation results.</td><td>Urban Planner, Simulation Platform</td></tr>
</table></td></tr>
<tr><td>7 Requirements</td><td colspan="3">a) Hardware requirements: need to have strong computing power equipment to support the simulation platform running
b) Software requirements: a mature simulation platform capable of simulating all elements required for urban planning
c) Outcome requirements: planning strategy should be recognized and run by the simulation platform</td></tr>
<tr><td>8 General remarks if any</td><td colspan="3"></td></tr>
<tr><td>9 Special use case if any</td><td colspan="3"></td></tr>
</table>

B.4 Plan review and approval

B.4.1 Present for review

1 Basics	**1.1 Name**	Present for review
	1.2 Domain	Plan review and approval
2 Narrative		Urban planning projects will not exist independently, but will be closely related to the surrounding environment and infrastructure conditions. In the process of urban planning, the impact on the surrounding environment should be considered, as well as the carrying capacity of the relevant municipal infrastructure and its supporting connection. Therefore, in the planning review stage, the public and officials need to review and feedback the planning decision results. Officials pay more attention to whether the planning results meet the requirements of upper planning and are coordinated with the urban environment and facilities, while citizens pay more attention to the spatial experience and functional richness of urban planning.
3 Objectives		a) High precision, zero error, low cost of urban planning results review. b) The public can quickly understand the implications of planning decisions and are interested in providing active feedback.
4 Background	**4.1 Current Practices**	The application of smart technologies for the presentation and review of planning results has been explored globally. China, Japan, Singapore and other countries have implemented automatic planning approval on urban planning platforms, and many community plans in the United States, Europe and other countries use interactive and 3D visualization technology to enhance public participation. In England, UK, a "new planning system" that has seen new housing, hospitals, schools, shops and offices on land designated for growth automatically granted with "permission in principle" given in renewal areas to ensure appropriate checks are carried out.

	4.2 Potential Technology	a) Techniques used for 3D model index comparison technology Three-dimensional spatial visualization is a means of describing and understanding models, a representation of data, not a simulation technology. It can make use of large amounts of data, check the continuity of data, identify the authenticity of data, discover and propose useful anomalies, and provide useful tools for analysing, understanding and repeating data. b) Techniques for visual presentation and interaction Virtual reality (VR) technology is a computer simulation system that can generate a simulation environment and immerse the user in the environment. In smart urban planning, VR technology is gradually being used to produce a virtual world for citizens to understand the content of planning and design.
	4.3 Gaps	a) Because of the approval of planning results in an artificial way, omissions, errors of judgment and other problems can easily occur. b) Faced with a large number of complex urban planning data reviews, planning approval department needs to spend a lot of energy to conduct data review. c) It is difficult for planning review departments to ensure that planning results are fully matched with urban facilities already built or under construction. d) It is difficult for the public to understand the blueprints from simple masterplans or bird's-eye renderings.

5 Ecosystem	**5.1 Stakeholders**	a) Stakeholder 1: planning review department Role: as primary beneficiary and owner Responsibilities: to be responsible for reviewing the urban planning results, including whether they meet the requirements of upper policies and whether the urban planning data are reasonable. b) Stakeholder 2: urban planner Role: as primary beneficiary and designer Responsibilities: to be responsible for the technical work of urban planning, to present the urban results for the government and the public, and modify the results according to the feedback. c) Stakeholder 3: public Role: as secondary beneficiary and user Responsibilities: responsible for providing planning advice from the user's perspective as an important part of public participation. d) Stakeholder 4: urban planning review platform Responsibilities: responsible for automated and large-scale approval of quantitative data in planning results.
	5.2 Relationships between the stakeholders	Urban Planners submit planning results to Planning Review Department and automate approval on the platform. Planners are opening the results to the public for comment, see Figure B.7.

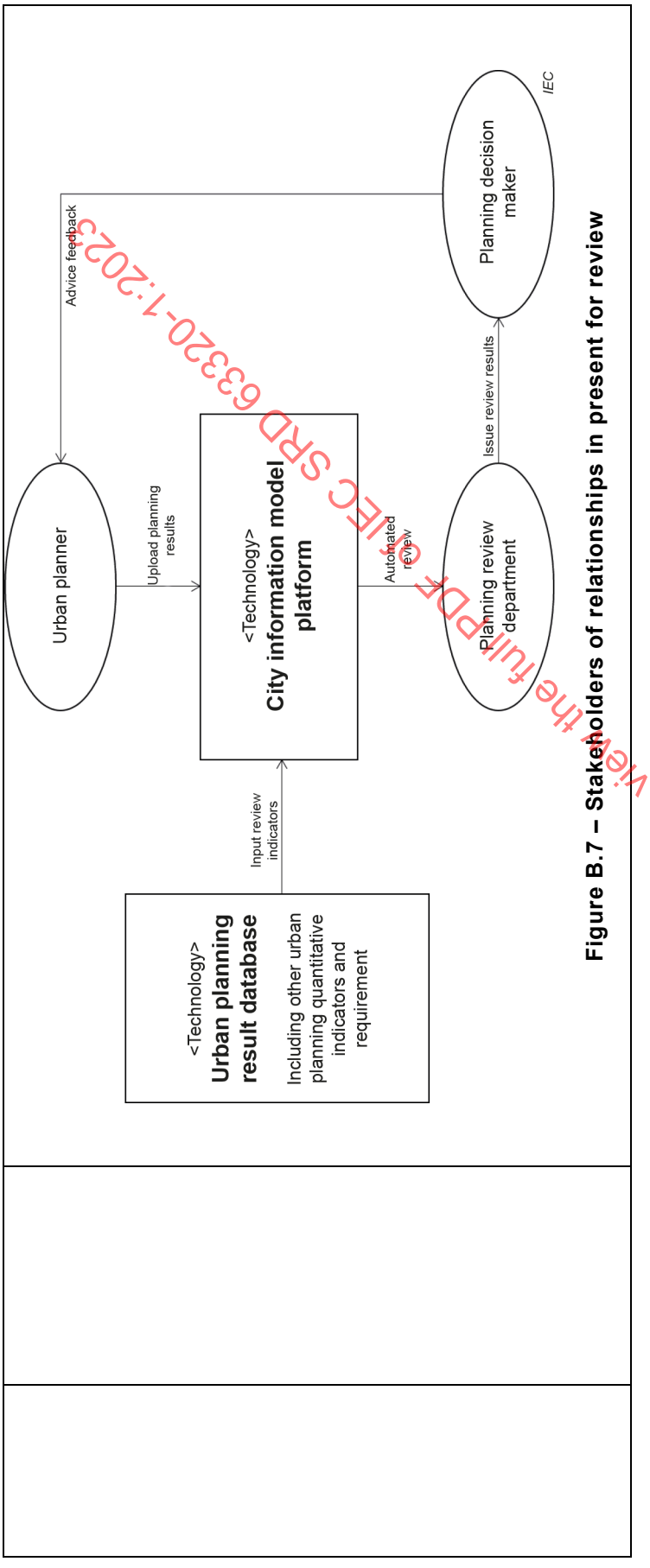


Figure B.7 – Stakeholders of relationships in present for review

	Name of action	Scope	Description	Actors involved
6 Scenarios	Upload Planning Results	The planner submits the planning results to the planning review platform.	According to the requirements of the urban planning review platform, the urban planner submits the planning outcome model containing all kinds of planning data to be reviewed	Urban Planner, Urban Planning Review Platform.
	Automated Review	Automatic review of planning results.	The urban planning review platform compares the urban planning result data with the upper policies in turn by means of index comparison and spatial model comparison.	Planning Review Department, Urban Planning Review Platform
	Public Display	3D visualization and interactive display of planning results.	Urban planners display the planning results through 3D visualization, and VR or AR and other interactive technologies to visually display the planning blueprint to the public, and improve the public's sense of interest and participation.	Urban Planner, Public
	Advice Feedback	Get feedback on planning results.	Urban planners obtain feedback from planning review departments and the public. Then they will modify the planning results	Urban Planner, Planning Review Department, Public

7 Requirements	a) **Software requirements:** A mature planning platform is required, and the platform should contain urban planning data and basic data. b) **Planning result requirements:** The planning outcome should not be limited to drawings, but also include 3D models for visualization and data models for platform review. c) **Work process requirements:** Government departments should formulate the working process of the examination and approval of the planning achievement platform to assist the actual examination and review work.
8 General remarks if any	
9 Special use case if any	

B.4.2 Approve and publish

SUP application area		
1 Basics	**1.1 Name**	Publish for review
	1.2 Domain	Plan review and approval
2 Narrative		Under the premise of very limited urban resources, urban planning mistakes can lead to huge waste and in the process of urban planning, stakeholders are active and extensive participation is an important factor to ensure the objective and scientific nature of urban planning. Therefore, the tripartite sharing of planning achievements is needed among the government, planners and the general public.
3 Objectives		a) The planning results need be published in accordance with the specified format and naming requirements b) Digital methods are needed to get citizens involved in the planning draft review process. c) Everybody involved in the participation process must have equal and fair access to information.
4 Background	**4.1 Current Practices**	a) Online service platform. People can use the internet to quickly access current planning regulations and standards, planning news and projects in city

4.2 Potential Technology	Cloud technology. With cloud technology, urban planners can create a database and publish the details of certain urban planning drafts or schemes, so as to achieve efficient sharing and exchange of city-wide data. Virtual reality technology. Virtual reality is also helpful in simulating scenarios to model urban environments in 3D. Through the use of advanced visualization techniques, urban planners can visualize different urban areas. In this way, potential environmental impacts can be projected. This leads to better understanding the content of planning and design in a dynamic interactive way, and improves the visualization ability of the planning scheme.
4.3 Gaps	a) Traditional methods often result in citizens having to read lengthy and complex documents unfamiliar to them, and they can also be extremely time-consuming. b) The majority of publication channel and consultation methods have been non-digital.

5 Ecosystem	**5.1 Stakeholders**	a) Stakeholder 1: planning department Role: primary beneficiary, owner and user Responsibility: the planning department is responsible for feedback on the automated review report and deciding whether to approve the project. b) Stakeholder 2: planning institute Role: primary beneficiary, user Responsibility: planning institute is responsible for revising the plan according to the advice provided by the planning department and uploading the improved plan to the platform for review. c) Stakeholder 3: digital approval and publish platform Role: tertiary beneficiary Responsibility: digital approval and publish platform is responsible for providing intelligent project approval and publication capabilities. d) Stakeholder 4: public participants Role: primary beneficiary Responsibility: public participants are responsible for obtaining the approval and public information of the scheme from the platform, and negotiating the modification opinions of the scheme with the government departments.
	5.2 Relationships between the stakeholders	The relationships between the stakeholders in approve and publish is as shown in Figure B.8.

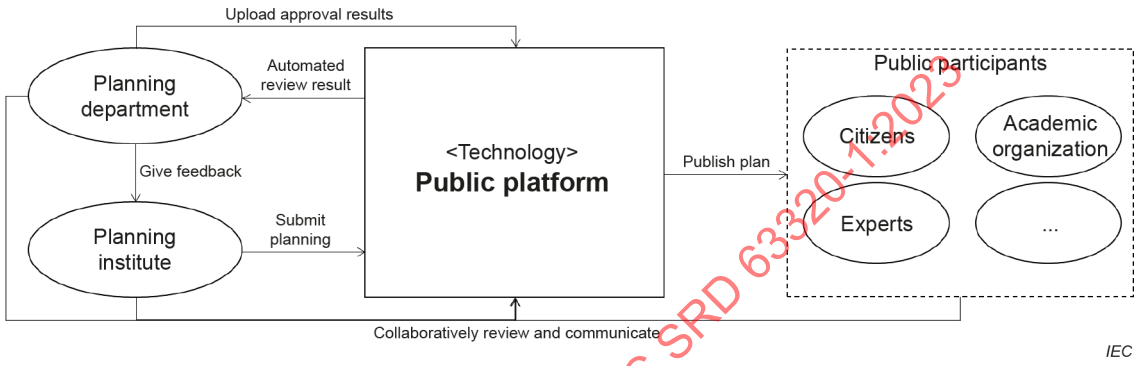


Figure B.8 – Stakeholders of relationships in approve and publish

	Name of action	Scope	Description	Actors involved
6 Scenarios	Output automated view report	To achieve efficient planning scheme review	The platform automatically checks whether the planning results meet relevant standards and requirements, and automatically outputs a review report. The planning department should, according to the contents of the report, issue revision opinions to the planning institute. If there is no problem, the planning department will upload approval result on the platform.	Planning department; Digital approval and publish platform
	Collaboratively review and communicate	Realize the collaborative evaluation and	Allow cross-departmental communication to	Planning department; Planning institute;

		review among all stakeholders	negotiate and modify the results of the review report	Digital approval and publish platform; Public participants
	Publish the final planning	The public participates in the process of plan approval and publicity interactively	The public can check the status of projects under planning approval in real time. At the same time, massive urban planning information is released to the public	Digital approval and publish platform; Public participants
7 Requirements	a) **Software requirements:** A mature planning platform is required, and the platform should contain comprehensive urban data. b) **Planning result requirements:** The planning outcome should not be limited to drawings, but also include 3D models for visualization and data models for platform review. c) **Work process requirements:** Government departments should formulate the working process of the examination and approval of the planning achievement platform to assist with the actual examination and review work.			
8 General remarks if any				
9 Special use case if any				

B.5 Plan implementation

B.5.1 Planning conditions formulation

1 Basics	**1.1 Name**	Planning conditions formulation
	1.3 Domain	Involve one or more of the six steps, including preparatory work, data collection and analysis, strategy formulation, plan review and approval, implementation, and monitoring and assessment. Plan Implementation
2 Narrative		Planning conditions are an important basis for handling land transfer, planning scheme design and subsequent planning management in the implementation process. Planning conditions meet the control requirements of public facilities, historical and cultural protection, traffic design, ecological low-carbon, urban design, underground space utilization, etc. Planning conditions involve many control elements, including land conditions (such as site boundary range, site area, land area), municipal conditions (such as culture, education, sports and other public service facilities, and water supply and drainage, electricity, telecommunications and other municipal infrastructure), transport condition (such as organization of traffic lines, main entrances and exits, connection with urban traffic facilities and parking lot space, etc), and heritage condition (the buildings and historical monuments need to be preserved and protected), etc.
3 Objectives		The application of various technologies in the formulation of planning conditions aims to make the formulation process more intelligent, standardized and easy to operate. For example: a) To refine and integrate the planning elements about building works and municipal works to form a standard text. b) To automatically extract plot drawing data, such as the land boundary line range. c) To automatically extract detailed control indicators such as land property, land area, plot ratio, building height and building density. d) To display current policy documents to help the planning condition makers easily set various control elements. e) To ensure the quality of planning condition results.

4 Background	**4.1 Current Practices**	The formulation process of planning conditions usually relies on manual acquisition and comparison of relevant control requirements and data constraints, from regulatory detailed planning, special planning, urban design and other upper planning requirements, as well as current policy documents and standard documents. These control requirements are set by different government departments of the city. When the urban planning authority puts forward planning and construction requirements for urban construction land, it should be based on numerous legal and non-legal planning principles,, as well as current situation data mapping results and operational performance data to issue the planning conditions of the project.
	4.2 Potential Technology	a) Data extraction technology helps to extract the control and planning index data and ensure that the planning conditions meet the control requirements of control and special planning. b) Data conversion technology helps to eliminate duplicate, invalid and incomplete data from multi-source heterogeneous data sources. It is helpful in forming unified and standardized planning condition results, and is conducive to the merger of buildings and municipal planning conditions, so as to improve the approval efficiency. c) Data verification technology helps to realize the verification and comparison between planning condition results and multi-source heterogeneous data sources including control and planning map library.
	4.3 Gaps	a) It is difficult to put forward comprehensive and detailed planning and management elements. b) It is difficult to issue standardized and template planning condition results. c) The planning conditions of building works and municipal works are handled separately, and the approval efficiency needs to be improved. d) The verification efficiency and quality of planning condition results is not high.
5 Ecosystem	**5.1 Stakeholders**	a) Stakeholder 1: construction unit Role: as primary beneficiary and owner of planning condition results. Responsibilities: provide the construction address, construction unit information, applicant information, project approval information, land transfer contract, land ownership and other basic information of the construction project. b) Stakeholder 2: planning condition formulation department