



BSI Standards Publication

Smart city use case collection and analysis — Smart urban planning for smart cities

Part 2: Use case analysis

National foreword

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A list of organizations represented on this committee can be obtained on request to its committee manager.

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**Smart city use case collection and analysis – Smart urban planning for smart cities –
Part 2: Use case analysis**



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SMART URBAN PLANNING FOR SMART CITIES –****Part 2: Use case analysis****FOREWORD**

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

Draft	Report on voting
SyCSmartCities/365/DTS	SyCSmartCities /376/RVDTS

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Specification 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 63320 series, published under the general title *Smart city use case collection and analysis – Smart urban planning for smart cities*, can be found on the IEC website.

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- revised.

INTRODUCTION

In recent years, research about 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. The concept of smart urban planning (SUP) has indeed gradually emerged with the development of smart cities. 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 SUP for smart cities 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.

Aiming 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 the SUP for smart cities reference model and reference architecture.

The target users and practitioners 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 that want to have a better understanding of SUP for smart cities;
- 4) SUP for smart cities operators who shall understand the requirements;
- 5) regulators who are responsible for developing and managing SUP for smart cities and related regulations.

The IEC SRD 63320 series contains two parts:

- IEC SRD 63320-1 which gives a high level analysis;
- IEC SRD 63320-2 which gives a use case analysis.

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

Part 2: Use case analysis

1 Scope

This part of IEC SRD 63320 deals with the smart urban planning (SUP) for smart city from the perspective of market relationship based on the analysis of IEC SRD 63320-1. This document establishes a framework between existing standards and stakeholder requirements, aimed at scoping out standard requirements and further standardization work. This document is a contribution to the IEC use case management repository, which aims to collect, administer, maintain, and analyse use cases.

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 terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://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 urban data collection, data analysis, 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

individual, team, organization (IEV 831-01-14), or classes thereof, having an interest in a system (IEV 831-01-21)

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

[SOURCE: IEC 60050-831:–, 831-04-05]

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 In smart grid or energy system area, generation, transmission, distribution, customer.

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

[SOURCE: ISO/IEC 19501:2005, glossary, modified – Example and note to entry added.]

3.1.5

functional requirement

requirement that describes what the system shall do

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

[SOURCE: IEC PAS 62559:2008, 7.2.6.2]

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 PAS 62559:2008, 7.2.6.2, modified – Only "reliability" has been kept in Note 2 to entry.]

3.2 Abbreviated terms

AI	artificial intelligence
BIM	building information model
ICT	information and communication technology
IoT	Internet of Things
LPWAN	low-power WAN
SDG	sustainable development goals
SUP	smart urban planning
UAV	unmanned aerial vehicle
VR	virtual reality

4 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.

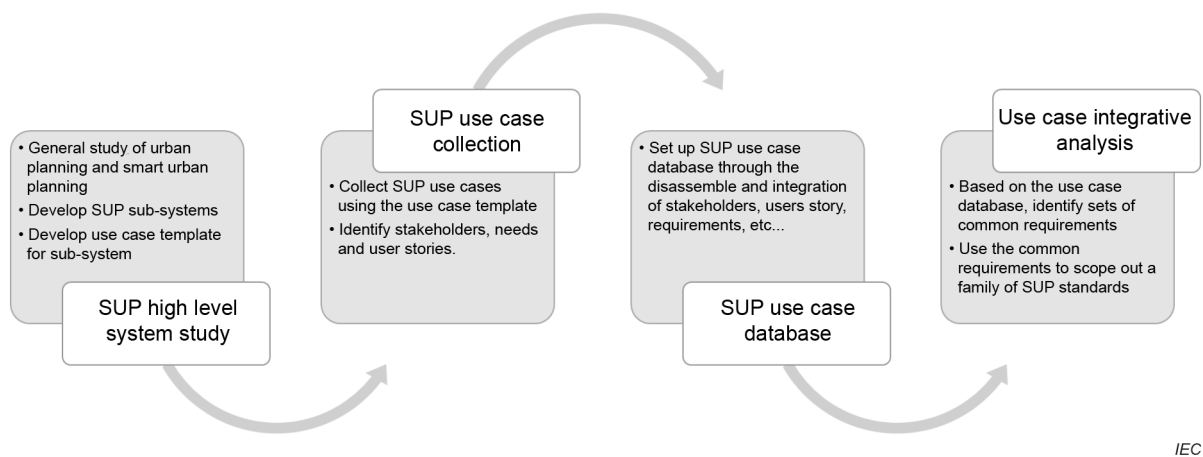


Figure 1 – Approach for use case collection and analysis

Firstly, a thorough study of smart urban planning is necessary at the beginning of use case collection and analysis. The purposes of the work of SUP high-level system study include identifying sub-systems, identifying basic stakeholder needs, and developing a SUP use case template for sub-system based on IEC TR 62559-1 and IEC 62559-2.

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 high-level use case database, and identify the standard gaps for smart urban planning and requirements a family of smart urban planning standards.

This document focuses on the third and fourth steps of the work approach.

5 Use case databases construction

5.1 General

Smart urban planning refers to a digital and intelligent urban planning system, in which advanced technologies are applied in all aspects, from pre-planning phase, planning phase and post-planning phase. Specifically, this document addressed the application area of:

- 1) planning tool inventory,
- 2) stakeholder identification,
- 3) urban data collection,
- 4) urban data analysis and interpretation,
- 5) parametric planning,
- 6) strategy analysis and comparison,
- 7) present for review,
- 8) approve and publish,
- 9) planning conditions formulation,

- 10)supervise implementation, and
- 11)dynamic monitoring.

Based on each of these application areas, we analysed the involved human actors and non-human actors. With reference to the urban planning process, we studied their possible decisions and actions, and the rationale behind. In Clause 5, we will first analyse the use cases for each application area to derive the related stakeholders with their user stories. The user stories focus on a statement explaining what the stakeholders are supposed to do, and what they need, under what kinds of certain circumstances. The structure is "as a" (title), "when I am" (situation), "I need to" (motivation), "so that" (outcome), allowing for a better integration of each stakeholder's motivation into a specific scenario for each use case, thus analysing their roles and thus understanding the mechanics of SUP's operation.

Considering the non-human actors that are interacting with the functioning of each application area, we observed the application of smart urban planning systems in them, which rely on the collaboration of multiple non-human actors, so that we continue to examine the use cases discussed above and summarise the non-human actors involved in each application areas, outlining their functional requirements and non-functional requirements. The tool requirement will centre on a statement explaining what the non-human actors are supposed to do, and what kind of achievement it should strike, with what kind of requirement it should satisfy. The structure is "When the" (title and situation), "it should" (function requirement), "so that it can" (outcome). The detail is shown in Figure 2.

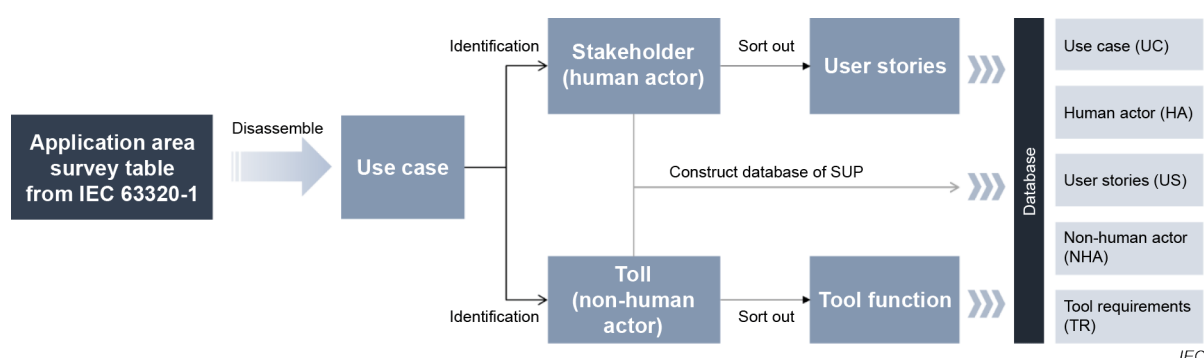


Figure 2 – Approach to database construction

Table 1 shows the dataset of use case analysis: covering the 11 application areas mentioned above, a total of 47 use cases were collected and then summarised into 81 human actors, 153 user stories, 39 non-human actors and 86 tool requirements.

The five database details on use cases, human actors, user stories, non-human actors, and tool requirements are in Annex A.

Table 1 – Database of use case analysis

No.	Name of the domain	Name of the application area	Use case analysis database				
			No. of UC	No. of HA	No. of US	No. of NHA	No. of TR
1.	Preparatory work	Planning tools inventory	6	11	24	3	8
2.		Stakeholder identification	7	9	15	3	6
3.	Data collection	Urban data collection	4	10	14	3	6
4.		Urban data analysis and interpretation	4	7	13	2	8
5.		Parametric planning	3	4	13	2	

No.	Name of the domain	Name of the application area	Use case analysis database				
			No. of UC	No. of HA	No. of US	No. of NHA	No. of TR
6.	Strategy formulation	Proposal analysis and comparison	4	8	14	4	11
7.	Plan review and approval	Present for review	4	5	14	3	6
8.		Approve and publish	4	6	14	4	7
9.	Plan implementation	Planning conditions formulation	4	6	10	5	12
10.		Supervise project implementation	4	7	9	6	8
11.	Monitoring and assessment	Urban dynamic monitoring	3	8	13	4	8
Total			47	81	153	39	86

5.2 Planning tool inventory

Smart urban planning platform is a digital platform, a tool which is the key to construction of smart city and the basic support for the pre-process of urban planning. It can realise 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, inquiry, information release and information feedback from the citizens and to the public. With quick access to urban information, planners can coordinate better with relevant agencies to facilitate integrated planning.

Based on collation and analysis in perspective of use case level, planning tool inventory consists of 6 use cases, seen in Annex A:

- 1) daily maintenance and development of the planning repository (UC-01);
- 2) daily supervision of the planning inventory (UC-02);
- 3) sharing of mass urban data (UC-03);
- 4) access to urban analytical models (UC-04);
- 5) access to the urban planning toolbox (UC-05);
- 6) customised development of urban planning tools(UC-06).

In terms of stakeholders (human actors), planning tool inventory involves 11 stakeholders, who are city operations official (HA-01), government official (HA-02), urban public sector and official (HA-05), internet platform company (HA-10), artificial intelligence company (HA-11), construction industry(HA-16), data engineer (HA-18), software engineer (HA-19), engineer of sensing and mapping (HA-20), urban planner (HA-21) and GIS engineer (HA-22). In addition, 24 user stories are sorted out around them.

In terms of smart tools (non-human actors), planning tool inventory involves 3 tools, which are urban data platform (NHA-01), urban algorithm platform (NHA-02), and urban planning toolset (NHA-03). In addition, 8 tool requirements are sorted out around them.

The relationships between the above elements are mapped to illustrate the interactions of various human and non-human actors (Figure 3). The diagram connects their user stories and requirements to better understand their motivations and roles.

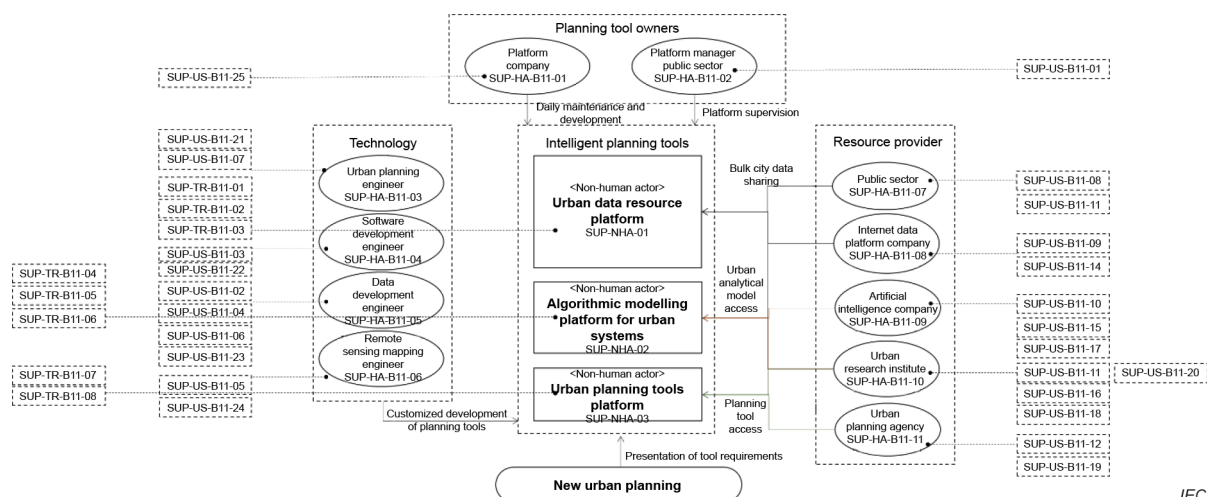


Figure 3 – Element map of planning tool inventory

5.3 Stakeholder identification

The application of stakeholder identification to the smart urban planning (SUP) aims to make appropriate decisions on urban planning by identifying the stakeholders' interests, domain, specificity and concerns, as well as managing the relationships, communication and conflicts between stakeholders; introduce useful stakeholder identification methods 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; and establish a transparent platform or channel supporting communication, collaboration and interaction to ensure that the project team can work from a range of locations to enter information about specific engagement activities and stakeholders based on identified stakeholders.

Based on collation and analysis in perspective of use case level, stakeholder identification consists of 7 use cases, seen in Annex A, namely management and maintaining of urban data repository (UC-07); customised data analysis (UC-08); city data and stakeholder information provision (UC-09); urban and regional data analysis tool provision (UC-10); inputting 2D and 3D data based on planning intentions (UC-11); potential stakeholder identification (UC-12); visualization of urban data presentation (UC-13).

In terms of stakeholders (human actors), stakeholder identification involves 9 stakeholders, who are government official (HA-02), urban platform authorities (HA-03), urban planning decision maker (HA-04), investor (HA-12), business owner (HA-13), real estate developer (HA-14), data engineer (HA-18), urban planner (HA-21) and citizen (HA-27). In addition, 15 user stories are sorted out around them.

In terms of smart tools (non-human actors), stakeholder identification involves 3 tools, which are urban data resource platform, urban data tool platform (NHA-01) and 3D visualization platform (NHA-04). In addition, 6 tool requirements are sorted out around them.

The relationships between the above elements are mapped to illustrate the interactions of various human and non-human actors (Figure 4). The diagram connects their user stories and requirements to better understand their motivations and roles.

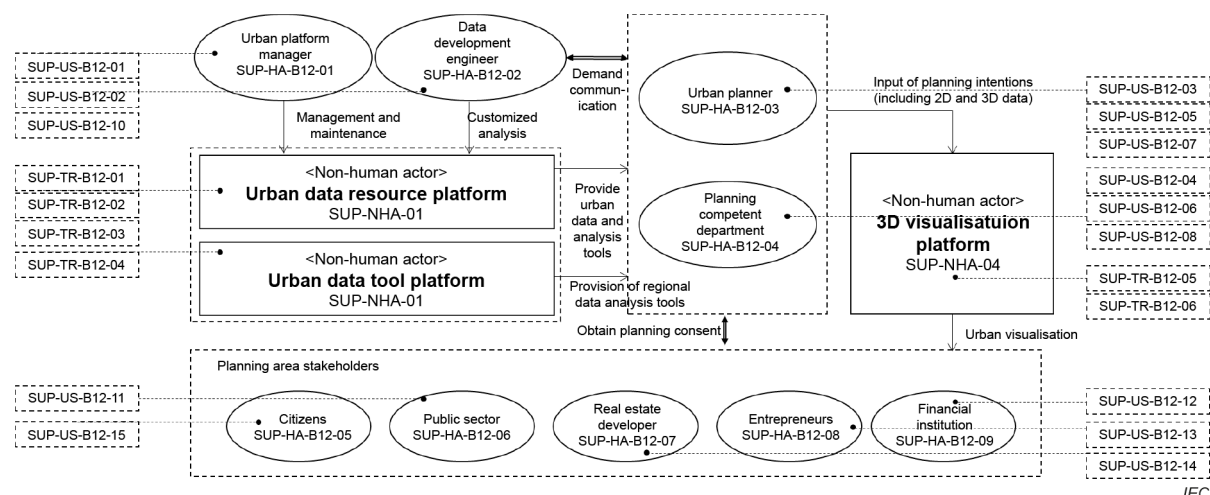


Figure 4 – Element map of stakeholder identification

5.4 Urban information collection

The application of urban information collection to the smart urban planning (SUP) aims to collect, collate, store, clean different types of primary or secondary data and invoke them in order, including demographic, geographic, economic, social, transportation and other relevant data; 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.; collect not only traditional government data, but relevant crowdsourcing data, Internet data, cell phone signalling, etc. as well; exchange and share information among different departments; and make quality check of the collected data to ensure the authenticity and availability.

Based on collation and analysis in perspective of use case level, urban information collection consists of 4 use cases, seen in Annex A, namely collection and entry of interview data (UC-14); bulk access of data from data platforms and IoT data collection (UC-15); cleaning of urban data (UC-16); bulk access of public data (UC-17).

In terms of stakeholders (human actors), urban information collection involves 10 stakeholders, who are government official (HA-02), urban platform authorities (HA-03), urban planning decision maker (HA-04), statistical department (HA-07), real estate developer (HA-14), data platform company (HA-15), urban planner (HA-21), data supervisor (HA-23), citizen (HA-27) and NPO (HA-28). In addition, 14 user stories are sorted out around them.

In terms of smart tools (non-human actors), urban information collection involves 3 tools, which are urban planning repository (NHA-05); IoT sensing terminal (NHA-24) and urban IoT Sensing platform (NHA-06). In addition, 6 tool requirements are sorted out around them.

The relationships between the above elements are mapped to illustrate the interactions of various human and non-human actors (Figure 5). The diagram connects their user stories and requirements to better understand their motivations and roles.

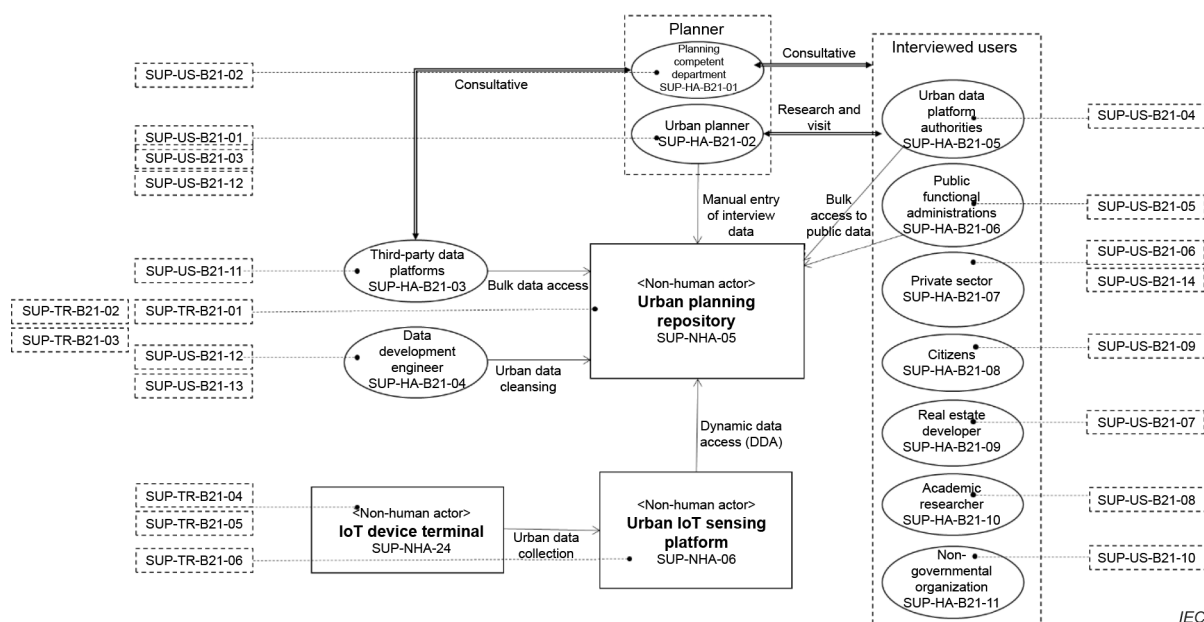


Figure 5 – Element map of urban information collection

5.5 Urban data analysis and interpretation

Urban data analysis and interpretation involve the collection, modelling, and analysis of data to extract insights that support data-driven decision-making, enabling governments to enhance overall performance. In smart urban planning, urban analysis encompasses various approaches, methods, and procedures that aid in our understanding of cities and urban life. It also supports public and civic leaders in their efforts to build smart, sustainable, and inclusive cities. From the planning repository where multi-technologies are employed, data regarding urban planning are input to data analysis platform, where technologies such as big data analysis, simulation modelling and analysis, and multi-source heterogeneous data fusion are utilised. These technologies aim to overcome the limitations of traditional urban analysis, which often suffer from inconsistencies, limited quantification, and limited data resources.

Based on collation and analysis in perspective of use case level, urban data analysis and interpretation consists of 4 use cases, seen in Annex A, namely provide analysis tools for further urban analysis (UC-18); provide analytical results to city operations departments (UC-19); provide and displaying analytical results to planning departments (UC-20); provide analytical results to investors (UC-21).

In terms of stakeholders (human actors), urban data analysis and interpretation involves 7 stakeholders, who are urban public sector and official (HA-05), statistical department (HA-07), business owner (HA-13), real estate developer (HA-14), data engineer (HA-18), urban planner (HA-21) and academic researcher (HA-24). In addition, 13 user stories are sorted out around them.

In terms of smart tools (non-human actors), urban data analysis and interpretation involves 2 tools, which are urban planning repository, data analysis platform (NHA-05). In addition, 8 tool requirements are sorted out around them.

The relationships between the above elements are mapped to illustrate the interactions of various human and non-human actors (Figure 6). The diagram connects their user stories and requirements to better understand their motivations and roles.

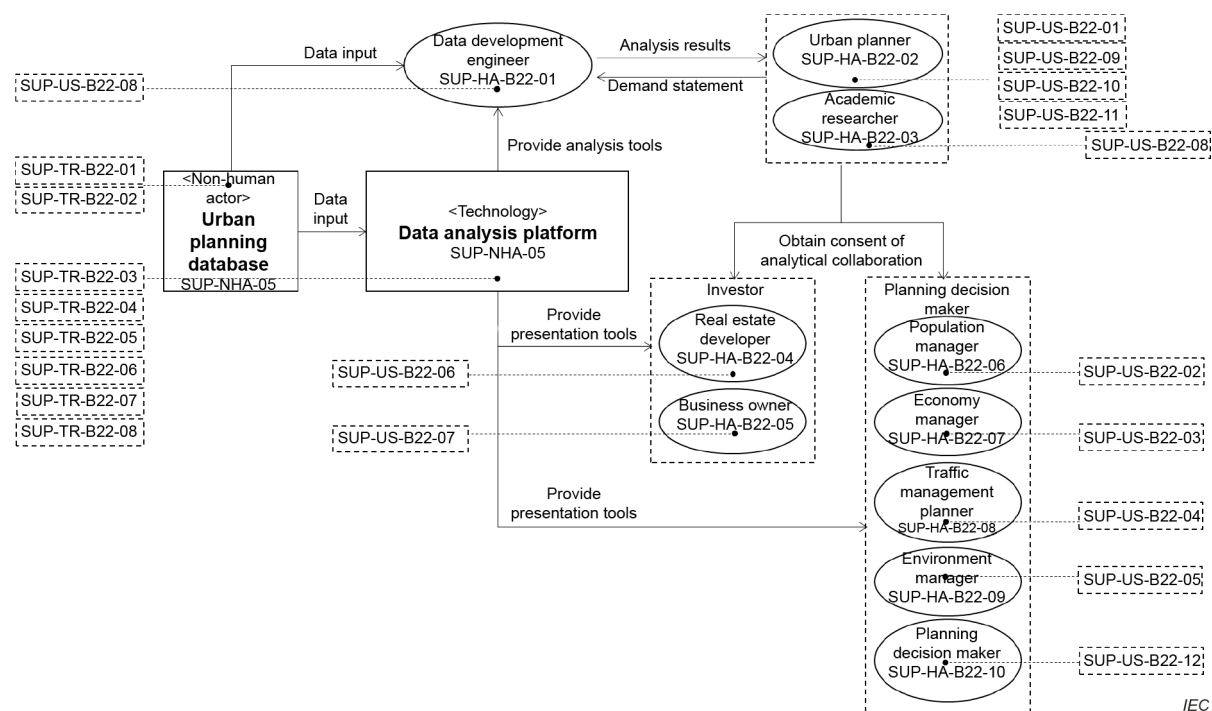


Figure 6 – Element map of urban data analysis and interpretation

5.6 Parametric planning

By utilising modelling technology, parametric algorithms, and deep learning, parametric planning facilitates quick and simplified generation of planning schemes. It combines computer and software with urban design, providing practicality and potential for addressing complex city systems. With the incorporation of deep learning technology, simulation and modelling technology, and parametric modelling technology, parametric planning brings efficiency and a fresh perspective to planners. This enables them to design cities in a more anticipatory and adaptable manner, where urban planner just input parameters they need.

Based on collation and analysis in perspective of use case level, parametric planning consists of 3 use cases, seen in Annex A, namely automatically generate planning scheme through parametric design (UC-22); display planning scheme and collect feedback from all parties for scheme optimization (UC-23); operation and maintenance of the database and platform (UC-24).

In terms of stakeholders (human actors), parametric planning involves 4 stakeholders, who are urban planning bureau (HA-08), data engineer (HA-18), urban planner (HA-21) and academic researcher (HA-24). In addition, 13 user stories are sorted out around them.

In terms of smart tools (non-human actors), parametric planning involves 2 tools, which are urban planning repository (NHA-05); parametric software (NHA-07). In addition, 6 tool requirements are sorted out around them.

The relationships between the above elements are mapped to illustrate the interactions of various human and non-human actors (Figure 7). The diagram connects their user stories and requirements to better understand their motivations and roles.

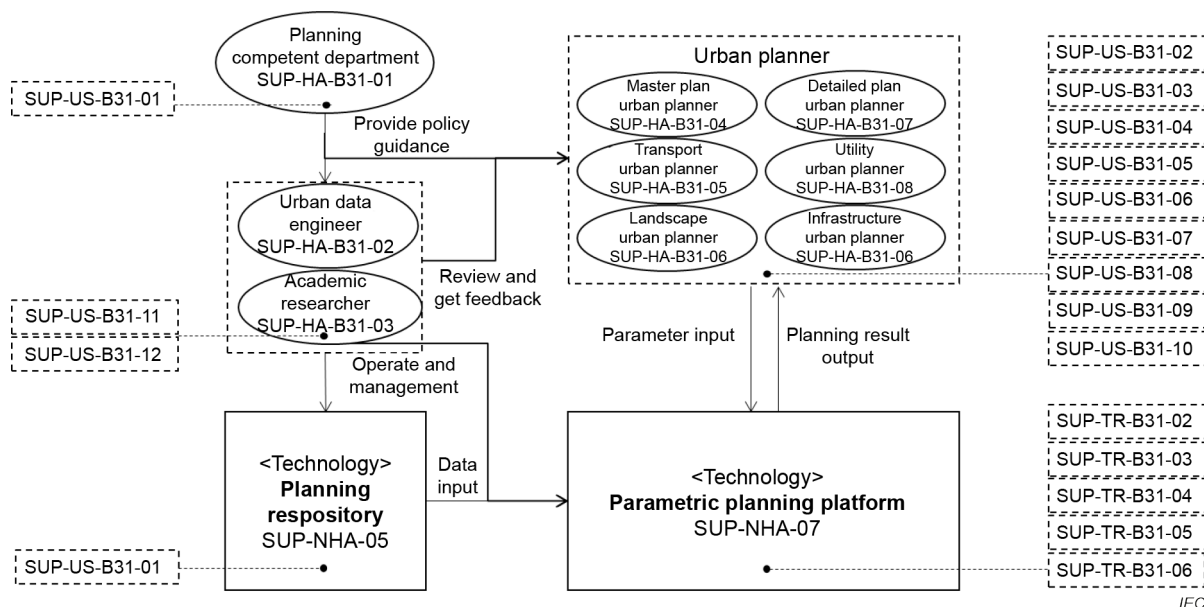


Figure 7 – Element map of parametric planning

5.7 Strategy analysis and comparison

The analysis and comparison of strategies or proposals serve as smart assistants to explore the positive or negative effects of different planning schemes and evaluate planning options during the initial development of potential planning schemes. With the aid of simulation and modelling technology, as well as virtual reality technology, the simulation analysis platform and the planning repository can more efficiently integrate knowledge from the planning domain and generative adversarial networks. Additionally, it provides advanced visualization techniques that assist urban planners in comparing different schemes and assessing their potential impact.

Based on collation and analysis in perspective of use case level, strategy analysis and comparison consists of 4 use cases, seen in Annex A, namely simulate micro urban elements to reflect any possible impacts of different planning strategies (UC-25); operation and maintenance of the database and platform (UC-26); analyse possible impacts of different planning strategies and do comparative analysis among them from multi perspective (UC-27); formulate the optimal planning strategy by collecting views from all parties and make modifications (UC-28).

In terms of stakeholders (human actors), strategy analysis and comparison involve 8 stakeholders, who are government official (HA-02), urban planning bureau (HA-08), investor (HA-12), real estate developer (HA-14), data engineer (HA-18), urban planner (HA-21), academic researcher (HA-24) and construction practitioner (HA-25). In addition, 14 user stories are sorted out around them.

In terms of smart tools (non-human actors), strategy analysis and comparison involve 4 tools, which are urban planning repository (NHA-05); urban regional repository (NHA-10); simulation analysis platform (NHA-08); 3D visualization platform (NHA-04). In addition, 11 tool requirements are sorted out around them.

The relationships between the above elements are mapped to illustrate the interactions of various human and non-human actors (Figure 8). The diagram connects their user stories and requirements to better understand their motivations and roles.

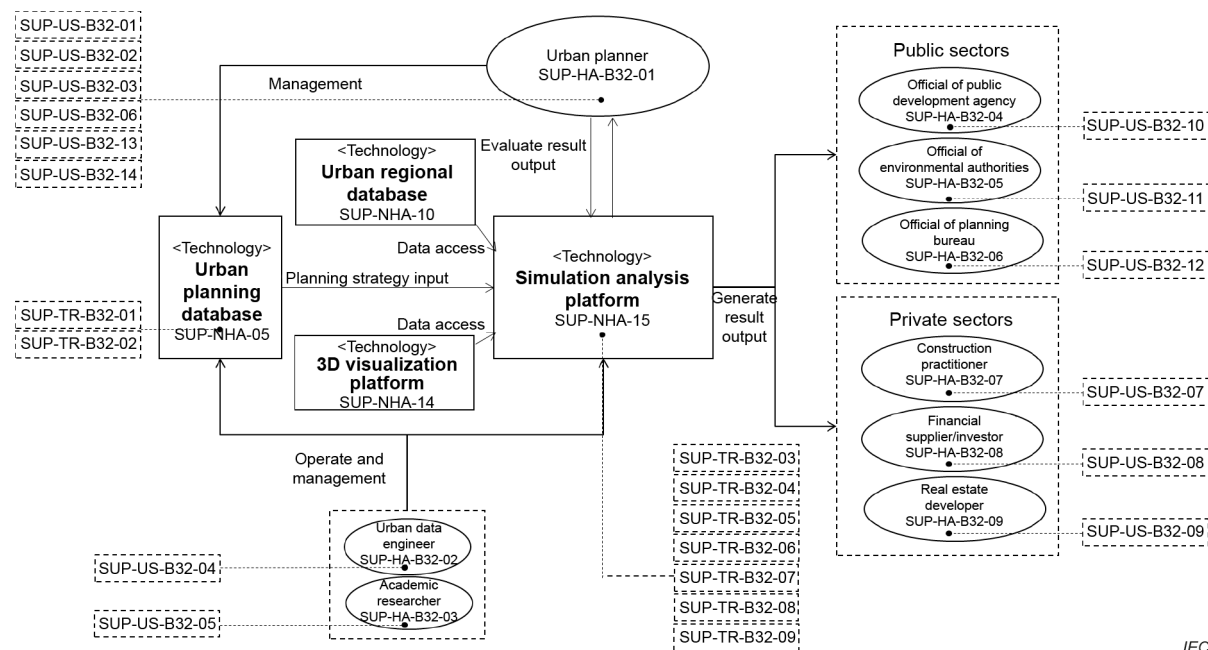


Figure 8 – Element map of strategy analysis and comparison

5.8 Present for review

The present review sector in urban planning projects involves considering the impact on the surrounding environment and the capacity of municipal infrastructure, as well as soliciting feedback from officials and the public during the planning review stage. Potential technologies for the review sector include 3D model index comparison techniques, which aid in data analysis and understanding, and visual presentation and interaction techniques such as virtual reality (VR) and augmented reality (AR), enhancing citizen's understanding. Those technologies are employed inside the city information model platform and the urban planning result database. Automated review is generated with the processing of the platform and the planning results uploaded by urban planner, which can address potential errors in manual approval, the complexity of reviewing large amounts of planning data, ensure alignment with existing infrastructure, and improve public understanding of planning blueprints.

Based on collation and analysis in perspective of use case level, present for review consists of 4 use cases, seen in Annex A, namely build the automated planning approval system of urban planning (UC-29); automated review of the consistency of planning schemes and specifications (UC-30); finalize the planning scheme and manage the data generated throughout the process (UC-31); operation and maintenance of the database and platform (UC-32).

In terms of stakeholders (human actors), present for review involves 5 stakeholders, who are urban planning decision maker (HA-04), urban planning bureau (HA-08), data engineer (HA-18), academic researcher (HA-24) and citizen (HA-27). In addition, 14 user stories are sorted out around them.

In terms of smart tools (non-human actors), present for review involves 3 tools, which are urban planning policy repository, planning review platform (NHA-05); CIM platform (NHA-12). In addition, 6 tool requirements are sorted out around them.

The relationships between the above elements are mapped to illustrate the interactions of various human and non-human actors (Figure 9). The diagram connects their user stories and requirements to better understand their motivations and roles.

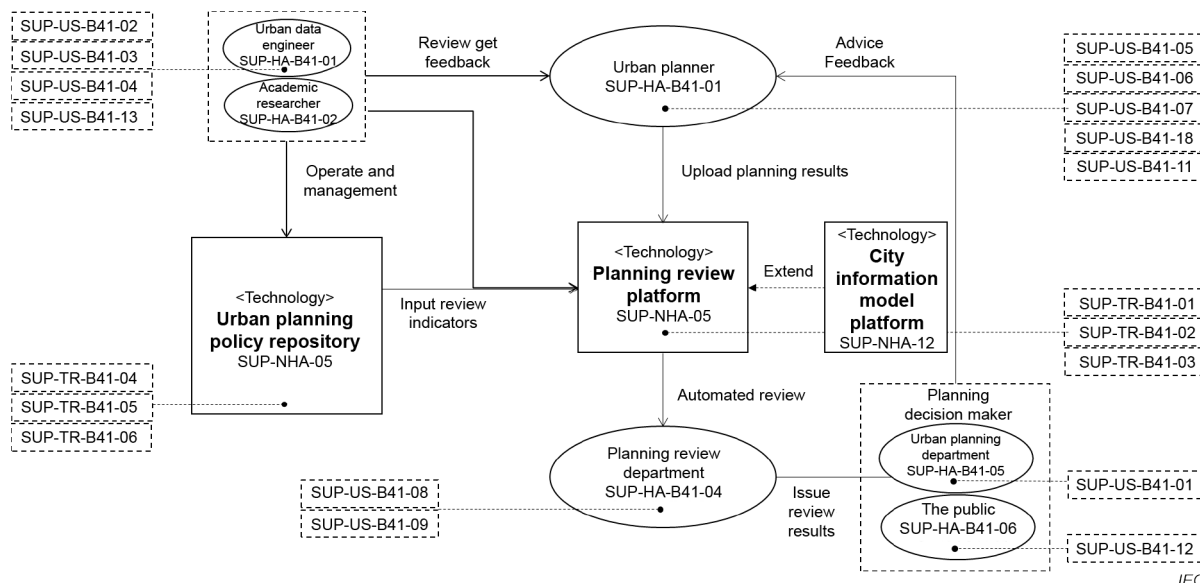


Figure 9 – Element map of present for review

5.9 Approve and publish

The approve and publish sector in urban planning projects aims to minimize mistakes and ensure the objective and scientific nature of planning through active stakeholder participation and the sharing of planning achievements among the government, planners, and the public. Traditional methods of document reading, and consultation have proven time-consuming and complex for citizens. To address these challenges, potential technologies for this sector include cloud technology, which enables efficient sharing and exchange of city-wide data through a database, and virtual reality technology have been employed in the public platform to publish plan for public participants and generate automated planning review, which facilitates dynamic and interactive visualization of urban environments, projecting potential environmental impacts and enhancing the understanding of planning and design.

Based on collation and analysis in perspective of use case level, approve and publish consists of 4 use cases, seen in Annex A, namely upload the urban planning result (UC-33); publish the well-informed and representative planning draft to the public (UC-34); involve the public in the process of collective decision-making once the planning draft published (UC-35); operation of the platform and the renewal of statistics (UC-36).

In terms of stakeholders (human actors), approve and publish involves 6 stakeholders, who are urban planning bureau (HA-08), data engineer (HA-18), urban planner (HA-21), academic researcher (HA-24), citizen (HA-27) and NPO (HA-28). In addition, 14 user stories are sorted out around them.

In terms of smart tools (non-human actors), approve and publish involves 4 tools, which are policy repository (NHA-11); government affairs platform (NHA-14); public service platform, planning exhibition centre (NHA-13). In addition, 7 tool requirements are sorted out around them.

The relationships between the above elements are mapped to illustrate the interactions of various human and non-human actors (Figure 10). The diagram connects their user stories and requirements to better understand their motivations and roles.

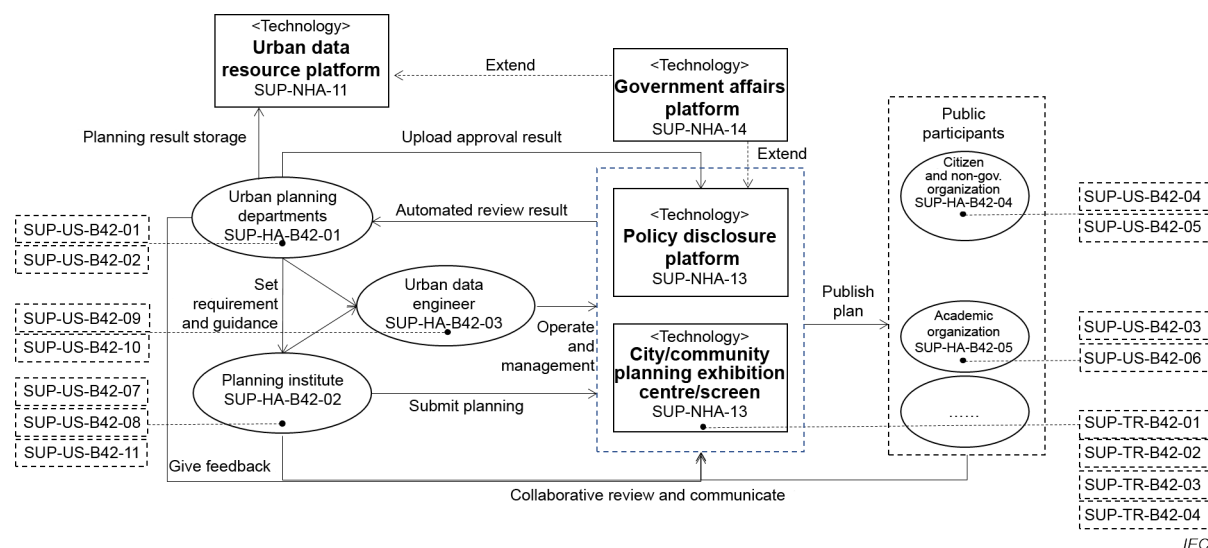


Figure 10 – Element map of approve and publish

5.10 Planning conditions formulation

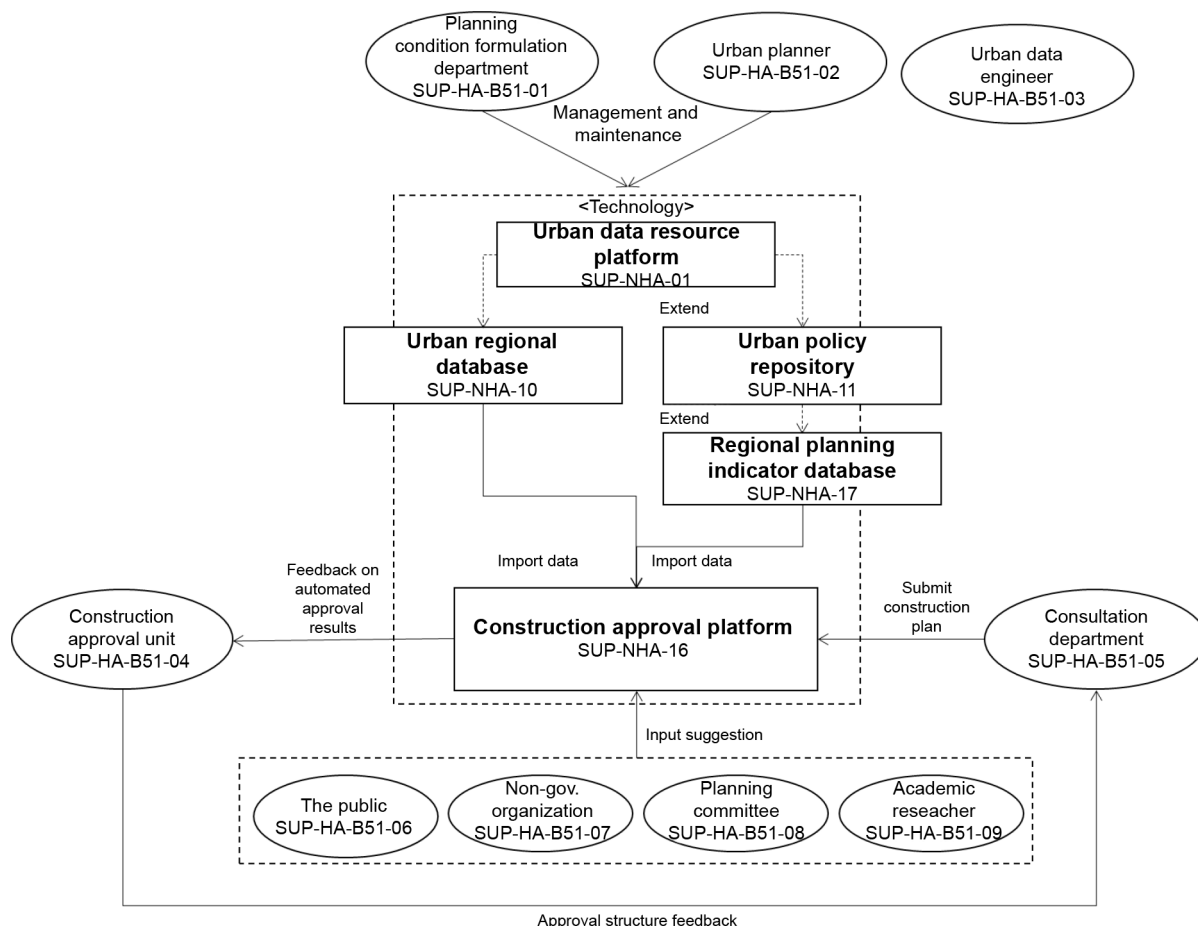
The planning conditions formulation sector in urban planning projects involves establishing the necessary conditions for land transfer, planning scheme design, and subsequent management. These conditions encompass various elements such as public facilities, historical preservation, traffic design, ecological considerations, urban design, and underground space utilisation. Currently, the formulation process relies on manual acquisition and comparison of relevant requirements and data constraints from different government departments. In the future, potential technologies for this sector include data extraction technology for retrieving control and planning index data, data conversion technology for eliminating duplicate and incomplete data, and data verification technology for ensuring consistency between planning conditions and various data sources. These technologies aim to improve the efficiency and accuracy of planning condition formulation. Supported by data fusion technologies where data extraction, data conversion and data verification are applied, the information system would generate planning conditions achievements. Such combination act as an assemblage to provide interaction with planning condition formulation department, construction unit, citizens, and consultation department.

Based on collation and analysis in perspective of use case level, planning conditions formulation consists of 4 use cases, seen in Annex A, namely organisation, operation, and maintenance of construction approval system (UC-37); apply for construction project planning conditions (UC-38); participation in the decision-making process and evaluation of the construction approval platform (UC-39); issue the planning condition formulation results to the construction unit (UC-40).

In terms of stakeholders (human actors), planning conditions formulation involves 6 stakeholders, who are urban planning bureau (HA-08), urban planner (HA-21), academic researcher (HA-24), construction practitioner (HA-25), citizen (HA-27) and NGO (HA-29). In addition, 10 user stories are sorted out around them.

In terms of smart tools (non-human actors), planning conditions formulation involves 5 tools, which are urban data platform (NHA-01); urban regional repository (NHA-10); policy repository (NHA-11); planning indicator repository (NHA-17); construction approval platform (NHA-16). In addition, 12 tool requirements are sorted out around them.

The relationships between the above elements are mapped to illustrate the interactions of various human and non-human actors (Figure 11). The diagram connects their user stories and requirements to better understand their motivations and roles.



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Figure 11 – Element map of approve and publish

5.11 Supervise implementation

The supervise implementation sector in urban planning and construction management plays a crucial role in monitoring and ensuring the successful implementation of projects. It helps identify and rectify deviations from the planned objectives caused by uncertainties in urban development and inherent flaws in urban planning. Currently, there is a need to leverage visualization environments for real-time progress monitoring using immersive technologies and the capabilities offered by 5G connectivity. Additionally, an automatic notification system can be implemented to alert managers of any schedule deviations or discrepancies. In the compounded planning supervision platform, potential technologies include remote sensing and mapping technology, building information modelling (BIM), computer vision-based technology, and virtual reality (VR) technology, which would enable automated progress monitoring, accurate data collection, and enhanced visualization, improving project control and efficiency as well as better coordinating other stakeholders.

Based on collation and analysis in perspective of use case level, supervise implementation consists of 4 use cases, seen in Annex A, namely operation and maintenance of the planning regulation platform (UC-41); providing engineering information for urban planning implementation (UC-42); providing feedback on planning approval and review results to relevant departments (UC-43); pre-input of demand parameters for urban planning implementation and project construction (UC-44).

In terms of stakeholders (human actors), supervise implementation involves 7 stakeholders, who are consultation department (HA-09), mapping company (HA-17), data engineer (HA-18), urban planner (HA-21), academic researcher (HA-24), construction practitioner (HA-25) and construction supervisor (HA-26). In addition, 9 user stories are sorted out around them.

In terms of smart tools (non-human actors), supervise implementation involves 6 tools, which are planning supervision platform (NHA-18), approved project database (NHA-19), satellite remote sensing system (NHA-20), UAV monitoring system (NHA-21), video terminal (NHA-22) and IoT sensing terminal (NHA-24). In addition, 8 tool requirements are sorted out around them.

The relationships between the above elements are mapped to illustrate the interactions of various human and non-human actors (Figure 12). The diagram connects their user stories and requirements to better understand their motivations and roles.

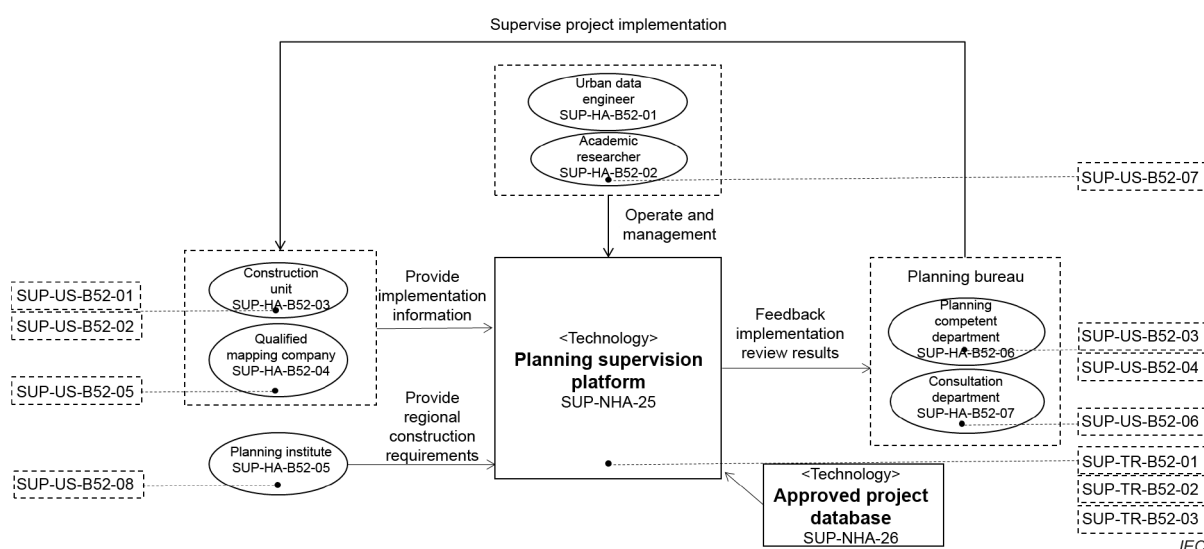


Figure 12 – Element map of supervise implementation

5.12 Dynamic monitoring

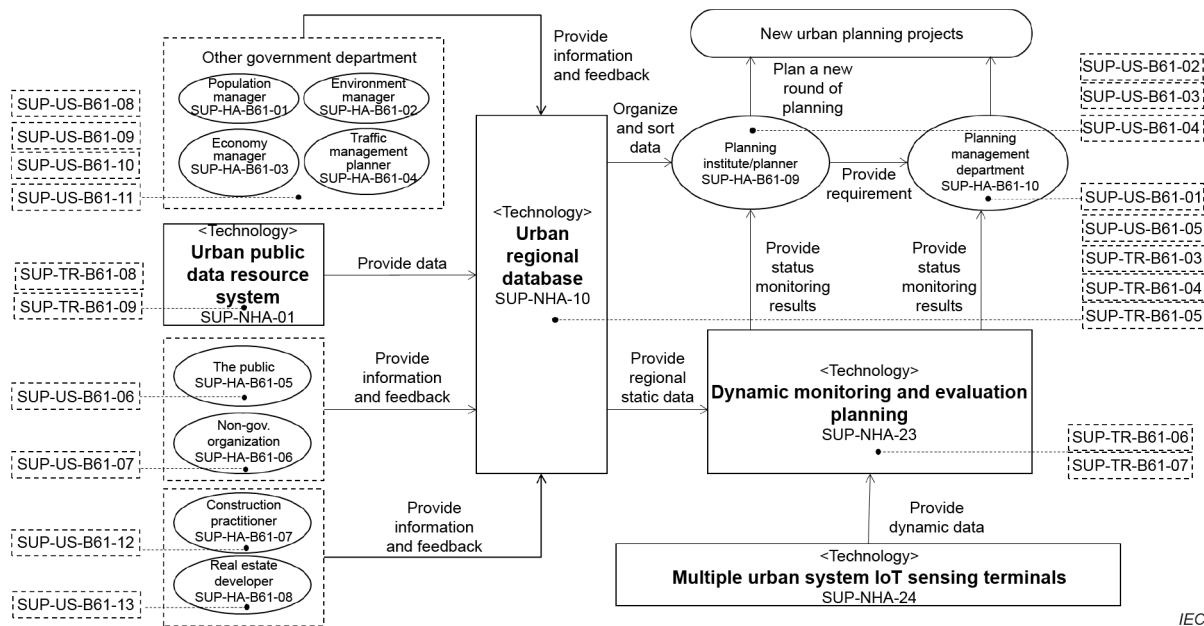
The dynamic monitoring sector in urban planning involves real-time monitoring, quantitative analysis, and regular publication of important indicators to assess the implementation of plans. Currently, monitoring and evaluation systems primarily focus on the master plan at an overall level, lacking attention to detailed planning. They face limitations in providing timely and useful information due to its reliance on negative feedback. Additionally, the indicator and evaluation system lack continuity and quantifiability. Future potential technologies include creating a high-performance platform, namely the dynamic monitoring and evaluation planning platform, supported by integrated planning repository with distributed micro-service architecture, implementing real-time data processing and mining analysis, and developing indicator models with dynamic configuration capabilities to support multi-dimensional and hierarchical management.

Based on collation and analysis in perspective of use case level, dynamic monitoring consists of 3 use cases, seen in Annex A, namely providing feedback information, including urban planning implementation, to the city regional database (UC-45); establish a dynamic monitoring, evaluation, early warning and implementation supervision mechanisms (UC-46); use the platform to obtain dynamic monitoring and assessment results (UC-47).

In terms of stakeholders (human actors), dynamic monitoring involves 8 stakeholders, who are urban planning decision maker (HA-04), urban public sector and official (HA-05), statistical department (HA-07), real estate developer (HA-14), urban planner (HA-21), construction practitioner (HA-25), citizen (HA-27) and NGO(HA-29). In addition, there are 13 user stories are sorted out around them.

In terms of smart tools (non-human actors), dynamic monitoring involves 4 tools, which are urban regional database (NHA-10), urban public data resource system (NHA-01); urban monitoring platform (NHA-23); IoT sensing terminal (NHA-24). In addition, there are 8 tool requirements are sorted out around them.

The relationships between the above elements are mapped to illustrate the interactions of various human and non-human actors (Figure 13). The diagram connects their user stories and requirements to better understand their motivations and roles.



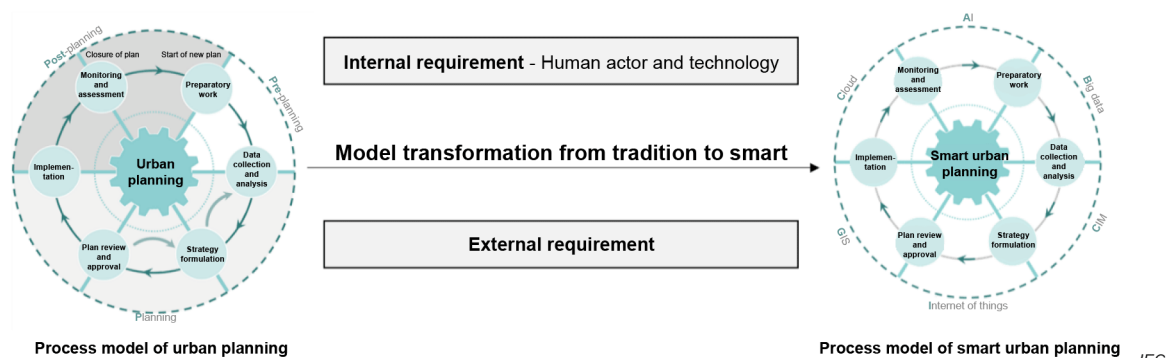
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Figure 13 – Element map of dynamic monitoring

6 Integrative analysis and results

6.1 General

The core of smart urban planning is the use of digital technology to improve the efficiency and quality of urban planning. For the application of one or more overlapping planning steps in the process of urban planning in various cities, Clause 6 will analyse the model transformational of smart urban planning from tradition to smart in perspective of internal requirements and external requirements, as illustrated in Figure 14.



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Figure 14 – Approach to integrative analysis of smart urban planning

Internal requirement refers to a series of resource requirements for people and technologies involved in smart urban planning. Clause 6 identifies and analyses the main requirements of people and technology based on the above five databases.

External requirement refers to the traction factors for smart urban planning, which push different domains of stakeholders to actively use digital technologies in the urban planning process. Clause 6 will be analysed through organizational, talent, innovation and other factors.