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Edition 1.0 2024-04

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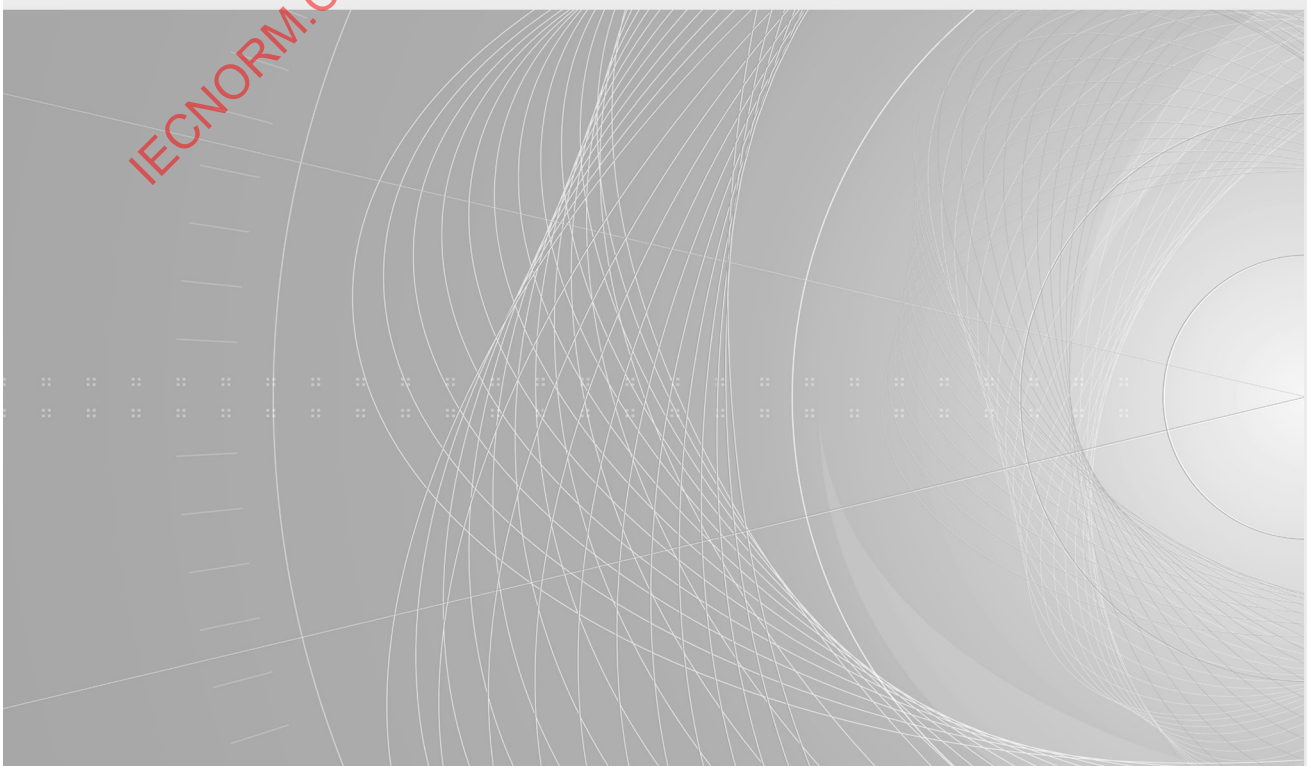
Smart city use case collection and analysis – City information modelling – Part 2: Use case analysis



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Smart city use case collection and analysis – City information modelling – Part 2: Use case analysis

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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SMART CITY USE CASE COLLECTION AND ANALYSIS – CITY INFORMATION MODELLING –

Part 2: Use case analysis

FOREWORD

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IEC SRD 63273-2 has been prepared by IEC systems committee Smart Cities: Electrotechnical aspects of Smart Cities. It is a Systems Reference Deliverable.

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

Draft	Report on voting
SyCSmartCities/317/DTS	SyCSmartCities/329/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 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 63273 series, published under the general title *Smart city use case collection and analysis – City information modelling*, 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- withdrawn, or
- revised.

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INTRODUCTION

The IEC SRD 63273 series aims to scope out the requirements of city information modelling standards by collecting and analysing its use cases. Specifically, the IEC SRD 63273 series achieves the objectives of:

a) identifying the key application areas and stakeholders;

b) developing user stories and clarifying the relationship among these stakeholders;

c) collecting and analysing use cases of city information modelling; and

d) scoping out the requirements for city information modelling standards and providing recommendations to IEC regarding urban planning and management.

The IEC SRD 63273 series supports the overall scope of IEC systems committee Smart Cities by:

a) promoting the collaboration and systems thinking regarding city information modelling standards;

b) contributing multiple domain-specific use cases for smart cities; and

c) supporting IEC in fostering the development of standards in the field of electrotechnology to help with the integration, interoperability, resiliency and effectiveness of city systems.

The IEC SRD 63273 series adopts a multi-step approach to generate and collect the use cases of city information modelling (see Figure 1).

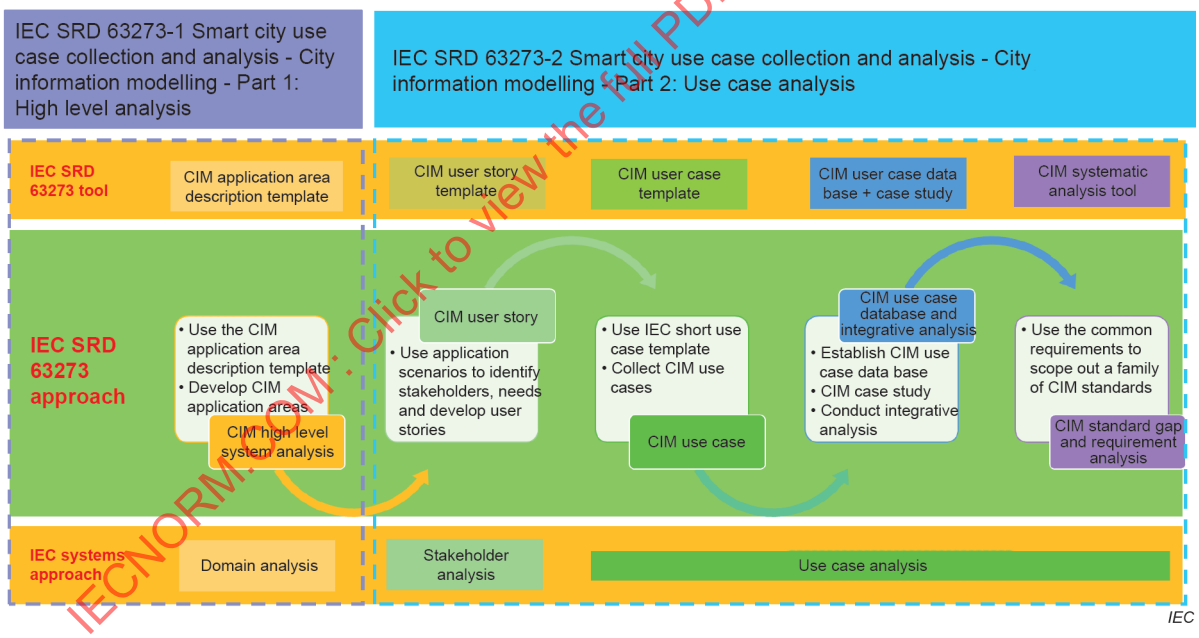


Figure 1 – City information modelling use case collection and analysis approach

Step I – High-level analysis: The first step aims to generate the list of application areas of city information modelling for a high-level analysis. Needs statements, objectives, current practices, gaps, and scenarios (rationale for applying city information modelling in a specific application area) are investigated for the description of each application area. In addition, the ecosystem, which includes the list of stakeholders and the relationship among the stakeholders, is examined in each application area before developing user stories and use cases.

Step II – User story: The second step aims to develop a list of significant user stories based on the corresponding application area. In each corresponding area, one user story is generated for one specific stakeholder which has been identified in Step I. 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).

Step III – Use case: The third step aims to develop use cases for a specific application area according to the list of user stories that have been generated in Step II. One user story in Step II can be expanded to be at least one use case. The organization of use cases follows the IEC short use case template (IEC TR 62559-1:2019, IEC 62559-2:2015 and IEC 62559-3:2017), which includes the name of the use case, scope, objective, narrative and list of actors.

Step IV – Use case database establishment and integrative analysis: This step is to establish the use case database of city information modelling and conduct integrative analysis of these use cases.

Step V – City information modelling standard gaps and requirements: This last step is to identify the standard gaps for city information modelling and requirements of the family of city information modelling standards.

The IEC SRD 63273 series contains two parts:

- IEC SRD 63273-1, Smart city use case collection and analysis – City information modelling – Part 1: High-level analysis
- IEC SRD 63273-2, Smart city use case collection and analysis – City information modelling – Part 2: Use case analysis

The scopes of the two parts are defined below.

Part 1 explains how the work of city information modelling use case collection and analyses address sustainable development goals, provides a brief overview of city information modelling, and identifies the key application areas and stakeholders of city information modelling.

Part 2 develops the list of user stories and the database of use cases, conducts integrative analyses of the use cases, scopes out the requirements of city information modelling standards and provides recommendations for IEC and other standards development organizations (SDOs) regarding urban planning and management.

In addition, according to the up-to-date understanding, urban digital twins are also used for describing such a type of solution for applying data and technology for better city planning and management. Urban digital twins indicate the digital twins at the urban scale to enable transformation in how cities are planned, built and managed to deliver better services to make the urban environment more liveable, inclusive, safe, resilient and sustainable. Therefore, the application areas, stakeholders, user stories and use cases of city information modelling, which are identified and developed in The IEC SRD 63273 series, are also applicable to urban digital twins to a great extent.

SMART CITY USE CASE COLLECTION AND ANALYSIS – CITY INFORMATION MODELLING –

Part 2: Use case analysis

1 Scope

This part of IEC SRD 63273 develops the list of user stories and the database of use cases, conducts integrative analyses of the use cases, scopes out the requirements of city information modelling standards and provides recommendations for IEC and other standards development organizations (SDOs) regarding urban planning and management using city information modelling.

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
city information modelling
CIM
development of digital representations and simulations of a city made up of large quantities of geospatial data, often including real-time data, which enable better city planning and management

Note 1 to entry: The geospatial data are provided using an integration of building information modelling (BIM) and geographic information systems (GIS).

Note 2 to entry: The real-time data are obtained through extensive use of IoT sensors within the city.

Note 3 to entry: City information modelling involves handling large amounts of big data, which are generally brought together using cloud computing.

Note 4 to entry: Artificial intelligence is often used to generate and evaluate different scenarios using city information modelling data to help manage the city better.

3.1.2
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 60050-741:2020, 741-01-30, modified – The original Note 1 to entry has been replaced.]

3.1.3
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]

3.1.4
geographic information system
GIS
information system dealing with information concerning phenomena associated with location relative to the Earth

[SOURCE: ISO 19101-1:2014, 4.1.20]

3.1.5
building information modelling
BIM
use of a shared digital representation of a built object (including buildings, bridges, roads, process plants, etc.) to facilitate design, construction and operation processes to form a reliable basis for decisions

Note 1 to entry: The acronym BIM also stands for the shared digital representation of the physical and functional characteristics of any construction works.

[SOURCE: ISO 29481-1:2016, 3.2]

3.1.6
Internet of Things
IoT
infrastructure of interconnected entities, people, systems and information resources together with services which processes and reacts to information from the physical world and virtual world

[SOURCE: IEC 60050-741:2020, 741-02-01]

3.1.7
big data
extensive datasets – primarily in the data characteristics of volume, variety, velocity, and/or variability – that require a scalable technology for efficient storage, manipulation, management, and analysis

Note 1 to entry: Big data is commonly used in many different ways, for example as the name of the scalable technology used to handle big data extensive datasets.

[SOURCE: ISO/IEC 20546:2019, 3.1.2]

3.1.8
cloud computing
paradigm for enabling network access to a scalable and elastic pool of shareable physical or virtual resources with self-service provisioning and administration on-demand

Note 1 to entry: Examples of resources include servers, operating systems, networks, software, applications, and storage equipment.

[SOURCE: IEC 60050-741:2020, 741-01-07, modified – Note 1 to entry has been added.]

3.1.9
artificial intelligence
AI
<discipline> research and development of mechanisms and applications of AI systems

Note 1 to entry: Research and development can take place across any number of fields such as computer science, data science, humanities, mathematics and natural sciences.

[SOURCE: ISO/IEC 22989:2022, 3.1.3]

3.1.10
city model
appropriate set of data which models those physical and social aspects of the city that are relevant for its objectives

[SOURCE: ISO/IEC 30146:2019, 3.5]

3.1.11
spatiotemporal data
data representing a set of direct positions in space and time

3.1.12
application
set of technologies deployed to fulfil a particular purpose

[SOURCE: IEC 60050-741:2020, 741-01-02, modified – In the definition, "software designed" has been replaced by "set of technologies deployed".]

3.2 Abbreviated terms

2D	two dimensional
3D	three dimensional
AI	artificial intelligence
BIM	business information modelling
CEO	chief executive officer
CIM	city information modelling
GIS	geographic information system
IoT	Internet of Things
ITS	intelligent transport system
SDGs	Sustainable Development Goals
SDOs	standards development organizations

4 User stories of city information modelling in different application areas

4.1 General

CIM can be applied in a vast scope of areas, including urban planning, whole lifecycle of construction project management, disaster management, heritage preservation, transportation planning and management, water and urban utilities management. User stories are useful to capture the description of the CIM platform from the users' perspectives. This document addresses the CIM user stories in the following application areas (AAs):

1) new town planning;
2) three-dimensional visualization of property and land administration;

3) construction approval management;
4) project management during construction;
5) real estate registration management;
6) city management using city brain;
7) heritage preservation and revitalization;
8) transportation infrastructure planning;
9) traffic management;
10) water management;
11) smart census project;
12) urban underground pipeline management based on data lake; and
13) emergency management and rescue.

The template of user story is as following:

As a/an <type of user>, when <situation>, I want <motivation> so that <expected outcomes>.

4.2 New town planning

CIM-US-NTP-01: As an urban planner, when I am developing plans for the new town area, I want to access a large amount of planning relevant data, so that I can organize and analyse the data in a way that helps me to understand its relevance to the planning.

CIM-US-NTP-02: As an urban planner, when I am developing plans for the new town area, I want to be able to easily aggregate and analyse that data without needing high-level data analyst skills, so that I can make precise estimation and simulation on specific themes which includes but is not limited to population growths, housing and traffic needs for the new town planning.

CIM-US-NTP-03: As an urban planner, when I am collecting comments from different stakeholders, I want to provide a three-dimensional (3D) visualization of the planning concept and details, so that I can help different stakeholders to understand the picture of the new town.

CIM-US-NTP-04: As an urban planner, when I am collecting comments from different stakeholders, I want to offer the modelling of simulations in different scenarios, so that I can provide evidence as to the different types of impacts of different options to enable stakeholders to compare the different options better.

CIM-US-NTP-05: As an urban planner, when I am collecting comments from different stakeholders, I want to make it easy for people to understand the benefits of the plans, so that once they have been finalized, people will decide to move to the new town, even before it is finally built and thus help it be more successful.

CIM-US-NTP-06: As an urban planner, when I am developing plans for the new town area, I want to communicate with and collect the comments from different stakeholders, so that I can provide a new town plan which can enable the different stakeholders to have a better life and employment in the new town and increase its sustainability.

CIM-US-NTP-07: As a real estate developer, when I want to decide to submit a tender for a land sale programme, I want to know the type of people who will be living there and how much they will be able to afford to pay for the housing so that I can maximize the benefit and minimize risk for the company.

CIM-US-NTP-08: As a real estate developer, when I want to make the decision to submit a tender for a land sale programme, I want to know whether any other facilities will be provided that can add to the value to the building, which includes but is not limited to new metro station, new schools, shopping centre so that I can maximize the benefit and minimize risk for the company.

CIM-US-NTP-09: As a real estate developer, when I want to submit planning for the land use, I want to know the requirements of the quantity, quality and style of buildings, so that I can maximize the benefit and minimize risk for the company.

CIM-US-NTP-10: As a real estate developer, when I want to submit planning for the land use, I want to make effective planning on the land use and present the planning multi-dimensionally, so that I can maximize the benefit and minimize risk for the company.

CIM-US-NTP-11: As a business owner, when I am making comments on the planning, I want to know the position and function of the new town, type of residents, buildings and facilities which will be in the new town, so that I can make comments from the perspectives of a business owner.

CIM-US-NTP-12: As a business owner, when I am making the decision to move the company to the new town, I want to decide whether or not this new town will be suitable for my company before the town is actually built so that I can ensure the company development and extend profit.

CIM-US-NTP-13: As a local community member in the new town area, when I am aware that there will be new town planning in my community, I want to understand the new town planning and present my comments, so that I can protect my original living environment and habits.

CIM-US-NTP-14: As a nonlocal community member, when I am asked for comments on the new town planning, I want to know whether this new town might be a suitable place for me to move my home so that I can see if it is relevant for me to comment on the proposals.

CIM-US-NTP-15: As a nonlocal community member, when I am aware that there will be a new town in my area, I want to understand the new town planning, so that I can decide where to live in the new town and what kind of property I want to live in.

CIM-US-NTP-16: As a nonlocal community member who is going to move their life into the new town, when I am aware that there will be new town planning in my community, I want to understand the new town planning and present my comments, so that I can select the proper community and real estate for the family.

CIM-US-NTP-17: As a nonlocal community member who is going to move their work into the new town, when I am aware that my company will move to the new town, I want to understand the new town planning, so that I can comment what transport facilities I need in the new town.

CIM-US-NTP-18: As an urban planning decision maker, when I am putting the new town on exhibition for comments, I want to display the plan multi-dimensionally for the general public, so that I can be sure that the general public makes informed comments on the plans and I can make the final decision of approving the planning by knowing that the result will be popular and that the general public will enjoy living and working in the new town.

4.3 Three-dimensional visualization of property and land administration

CIM-US-3DV-01: As a local community member, when I am aware that new developments go on public display for comment, I want to know if there are any developments that affect my community in a negative way, so that I can comment and raise concerns about this development before approval is granted.

CIM-US-3DV-02: As a local government assessment officer, when I am collecting comments from different stakeholders, I want to review the current developments underway in a 3D visualization platform, so that I can integrate the public exhibition of plans with the planned land use and long-term projects of land use in that local precinct.

CIM-US-3DV-03: As a local government assessment officer, when I am putting new developments on exhibition in a 3D visualization platform, I want to ensure that the public can review and comment on the development whilst other factors are under review, so that I can respond to the public's needs and understand how they view their community, its growth and development.

CIM-US-3DV-04: As a local government assessment officer, when I am putting new developments on exhibition in a 3D visualization platform, I want to ensure that the proposed development and its physical impact on the built environment are more quickly understood by special interest groups, so that I can assess whether there are negative impacts on the community in relation to its unique features, needs and characteristics. .

CIM-US-3DV-05: As a platform maintainer, when I am collecting data from project scheme designer, I want to upload, retire, and maintain the development applications in both a spatial and temporal maintenance environment, so I can deliver accurate urban development changes to different stakeholders.

CIM-US-3DV-06: As a project scheme designer, when I am planning a new development in a popular precinct in the city centre, I want to submit a 3D data file of my development for 3D visualization, so that I can accelerate approvals and transparency of the development.

CIM-US-3DV-07: As a local government certifier, when I am collecting comments from different stakeholders, I want to assess the development against local planning instruments and regulations to ensure it will pass requirements.

CIM-US-3DV-08: As a local government certifier, when I am collecting comments from different stakeholders, I want to provide a 3D visualization of the planning concept and details, so that I can help different stakeholders to understand a more holistic viewpoint of the development and its relationship to the urban growth.

CIM-US-3DV-09: As an advocacy and special interest group concerning climate, when I am aware of new developments, I want to ensure that they do not adversely affect the weather patterns within the city's microclimate, so that I can bring forward information and run simulations about the implications this may have on city's energy grid due to increases in building cooling systems being operated at one time.

CIM-US-3DV-10: As an advocacy and special interest group concerning climate, when I am aware of new developments, I want to ensure that the developments do not adversely affect the weather patterns within the city's microclimate in the form of heat islands, so that I can bring forward concerns or recommendations for the mitigating urban heat generation.

CIM-US-3DV-11: As an advocacy and special interest group concerning climate, when I am aware of new developments, I want to ensure that developments do not adversely affect the pollution levels within the city by removing important ventilation corridors, so that I can bring forward information about the potential impacts of the development on the cities air quality index and the health of residents.

CIM-US-3DV-12: As an advocacy and special interest group concerning disabilities, when I am aware of new developments, I want to ensure that developments do not inhibit wheelchair access and sight impaired people from navigating the space effectively, so that I can bring forward information about how this development can include and integrate disability access and avenues to facilitate all members of the community being able to navigate the space safely.

CIM-US-3DV-13: As an advocacy and special interest group concerning environment, when I am aware of new developments, I want to ensure that as the city grows that it does not remove essential ecological environments for fauna and adversely affect wildlife corridors and safe habitat for key species, so that I can bring forward information about the potential impact of the development on wildlife numbers or suggest mitigation strategies.

CIM-US-3DV-14: As an advocacy and special interest group concerning environment, when I am aware of new developments that can affect important biodiversity areas, I want to ensure that as the city grows that is does not remove essential ecological environments for flora, so that I can bring forward information about the potential impact of the development on essential plant species or suggest mitigation strategies.

4.4 Construction approval management

CIM-US-CAM-01: As a construction project review manager, when I am conducting a technical review of project programme indicators, I want to use the planning criteria as the basis for review, and carry out the technical comparison analysis and judgment, so that I can ensure legality and compliance of the construction application scheme.

CIM-US-CAM-02: As a construction project review manager, when I am in the process of comparing and selecting the project design schemes, I want to show several solutions and compare them on the same screen, so that I can choose a better design scheme to reorient the development of urban construction in a more intensive, beautiful and practical direction.

CIM-US-CAM-03: As a construction project review manager, when I am conducting a technical review of project programme indicators, I want to obtain information from various departments and industries to make comprehensive analysis and judgment, so that I can assess the accuracy of construction projects more scientifically and rationally, and therefore put forward reasonable suggestions.

CIM-US-CAM-04: As a real estate developer, when I am making land bidding decision, I want to know the type of people who will be living there and how much they will be able to pay for the housing, so that I can maximize the benefit and minimize risk for the company.

CIM-US-CAM-05: As a real estate developer, when I am starting a construction project design, I want to notify design company of the quantity, quality, style and requirements of buildings, so that I can maximize the benefit and minimize risk for the company.

CIM-US-CAM-06: As a real estate developer, when I am making a decision for construction project designs, I want to understand the designs in a multi-dimensional manner, so that I can maximize the benefit and minimize risk for the company.

CIM-US-CAM-07: As a real estate developer, when I am submitting project designs to government departments, I want to complete as many department approvals as possible through one-time document submission, so that I can save construction approval time.

CIM-US-CAM-08: As a real estate developer, when I am submitting project designs to government departments, I want to know approval results after submission effectively, so that I can assure the construction project starts on time and maximize the benefit.

CIM-US-CAM-09: As an architectural designer, when I am carrying out the design of urban commercial buildings, I want to obtain project planning requirements and surrounding conditions, and carry out skyline analysis, line sticking rate analysis, landscape analysis, etc., so that I can devise the optimal design plan that satisfies the design professionals.

CIM-US-CAM-10: As an architectural designer, when I am carrying out the delivery of construction project approval results, I want to review the project construction index to check whether it meets the requirements of the government construction indicators, so that I can formulate qualified construction project approval results and deliver them to real estate developers.

CIM-US-CAM-11: As a municipal designer, when I am carrying out the construction drawing design of the hydropower project in the residential area, I want to carry out collision detection of hydropower pipelines in residential quarters, so that I can find design loopholes, optimize the scheme to meet legal compliance requirements, and improve design quality and efficiency.

CIM-US-CAM-12: As a municipal designer, when I am carrying out the construction drawing design of the hydropower project in the residential area, I want to obtain information about the current status of hydropower in the neighbourhood, and compare it with my design plan, so that I can ensure that the hydropower project in the community is accurately connected to the city's hydropower system.

CIM-US-CAM-13: As a needs analyst for CIM platform and software, when I am conducting a demand survey of the CIM software, I want to collect information on functions of government departments, existing data, existing systems and approval business processes, so that I can provide detailed and accurate demand analysis to ensure software development.

CIM-US-CAM-14: As a CIM platform operator and maintainer, when I am maintaining the CIM platform, I want to know the environment configuration, data, user number and user feedback on the CIM platform, so that I can provide better technical support and maintenance for the proper operation of the platform and the approval of engineering construction projects.

CIM-US-CAM-15: As an academic researcher, when I am doing research on construction project review and approval big data, I want to collect, count, and analyse review and approval data from multiple dimensions such as time and space, so that the government has a better understanding of the project classification, funding sources, land use information, scale, etc. to assist scientific decision-making.

CIM-US-CAM-16: As a citizen who lives near the construction project, when I am making comments on the project review announced by government, I want to know the transportation, business and school that are provided by the project, so that I can understand the plan and offer a helping hand to make my living environment better in the future.

CIM-US-CAM-17: As a citizen who works near the construction project, when I am making comments on the project review announced by government, I want to know the traffic condition, commercial and office buildings that are provided by the project, so that I can understand the plan and actively engage in the project, making my working condition more convenient in the future, as well as providing me with more job opportunities.

CIM-US-CAM-18: As a business owner, when I am aware that the government has a new project being announced, I want to know the planning of the new project, including the buildings, transportation and other facilities, so that I can evaluate the project to decide whether I will invest here in the future.

CIM-US-CAM-19: As a transportation designer, when I am carrying out the design and drawing of urban road planning, I want to get information about the transportation facilities around the project, so that I can ensure the project can connect with the surrounding transportation facilities.

CIM-US-CAM-20: As a CIM platform development engineer, when I am developing the software, I want to know user's functional requirements for the software, so that I can ensure the software can meet users' requirements.

CIM-US-CAM-21: As a construction project public comment manager, when I am collecting public opinions, I want to quickly and accurately summarize public opinions through the platform, so that I can know exactly what the public think about the project.

CIM-US-CAM-22: As a construction project approval manager, when I am approving a project, I want to get the review results and citizens' opinion through the platform, so that I can decide accurately whether to approve the project.

4.5 Project management during construction

CIM-US-PMC-01: As a project scheme designer, when I am developing compliant design and creating the building model, I want to prepare the building information models precisely and provide information required by authorities and utilities in a timely manner, so that the models can be used to supply sufficient information to authorities and utilities to check and approve the design.

CIM-US-PMC-02: As a construction practitioner, when I am managing the delivery of the project and tracking its progress, I want to ensure the models are updated progressively and checked thoroughly so that I can hand over a correct model to the real estate developer, authorities and utilities with all the information required.

CIM-US-PMC-03: As a real estate developer, when I am providing updates to future owners for project progress and calculating the project risk, I want to be able to help my clients visualize the project progress and ensure regulators are satisfied with information in the model, so that I can minimize project risk and deliver a quality project on time and on budget.

CIM-US-PMC-04: As a utility services provider, when I am planning for new connection and existing services disruption, I want to visualize the project design and understand its interface with existing infrastructure so that I can review design and construction compliance and prepare contingency plan for any disruption.

CIM-US-PMC-05: As a construction regulator, when I am checking project compliance and investigating potential problems, I want the design and construction information to be readily accessible and analysable so that I can review all the assumptions made and track all the practitioners involved.

CIM-US-PMC-06: As a citizen who lives near the construction project, when I am reviewing what happens around my area, I want to visualize the project and have confidence in the delivery team, so that I can support the development.

CIM-US-PMC-07: As a construction project approval manager, when I am reviewing development applications and construction timeline, I want to analyse the impacts of the new development and its construction stage logistics so that I can make decisions on the submission with future in mind.

CIM-US-PMC-08: As an urban planner, when I am planning future infrastructure and services for citizens, I want to use data from CIM platform as a tool and analyse impacts of new projects so that I can deliver projects for my city with greater confidence.

CIM-US-PMC-09: As an asset manager, when I am assessing my facility performance and organizing maintenance works, I want to use the asset model to develop the asset digital twin so that I can gain insights into building performance and asset lifecycle management.

4.6 Real estate registration management

CIM-US-RER-01: As a real estate registration requirement specifier, when I am processing the registration application of the real estate owner, I want to draw up the business guidelines and regulations so that I can provide better convenience for real estate owners to apply for registration and make their materials meet relevant management technical requirements.

CIM-US-RER-02: As a real estate registration approval officer, when I am checking the payment status of deed tax, maintenance fund, loan and other expenses of real estate owners, I need to exchange and share information with real estate registration relevant business authority (including but not limited to taxation, banking, real estate, courts, etc.), so that I can accurately review the payment of real estate owners and complete the real estate registration.

CIM-US-RER-03: As a real estate registration approval officer, when I am conducting the first registration of the right to use construction land, I need to review the real estate registration application form, transfer contract, survey report and drawings, and land delivery confirmation in accordance with the rules and regulations so that I can assess the construction land situation more scientifically and rationally, and therefore complete the registration process.

CIM-US-RER-04: As a bank staff relevant to real estate registration, when I am handling the real estate mortgage loan application. I want to obtain the applicant's real estate registration information through CIM platform, so that I can evaluate the real estate value and decide the loan amount.

CIM-US-RER-05: As a tax staff relevant to real estate registration, when I am handling the real estate tax related business of the taxpayer. I want to obtain the real estate registration information of the applicant, so that I can quickly calculate the tax information.

CIM-US-RER-06: As a court staff relevant to real estate registration, when I am handling the seizure business. I want to obtain the real estate registration information of specific objects through CIM platform, so that I can quickly and accurately implement the seizure.

CIM-US-RER-07: As a real estate owner, when I am renovating my real estate, I want to view the 3D model and query properties of my own real estate through the CIM platform, so that I can better understand my real estate structure, and prepare for decoration.

CIM-US-RER-08: As a real estate owner, when I am applying for real estate registration, I want to know specific document requirements, so that I can avoid disapproval caused by not meeting registration document requirements.

CIM-US-RER-09: As a real estate owner, when I am applying for real estate registration, I want to know the address and process of registration, so that I can complete the registration at one time and save time.

CIM-US-RER-10: As a real estate owner, when I am applying for real estate registration, I want to obtain the legal digital version real estate certificate instead of the paper certificate, so that I can keep and use the certificate easily.

CIM-US-RER-11: As a CIM platform development engineer, when I am currently working on the development of the software, I want to learn the relevant specifications of the CIM platform, so that I can fully understand the system functions and design and better carry out software research and development.

CIM-US-RER-12: As a CIM platform operator and maintainer, when I am maintaining the CIM platform, I want to know the environment configuration, data, user number and user feedback on the CIM platform, so that I can provide better technical support and maintenance for the proper operation of the platform and the registration management of real estate.

CIM-US-RER-13: As an academic researcher, when I am doing research on real estate registration management big data, I want to collect, count, and analyse real estate data from multiple dimensions such as time and space, so that the government has a better understanding of the real estate classification, land use information, ownership information, scale, etc. to assist scientific decision-making.

CIM-US-RER-14: As a needs analyst for CIM platform and software, when I am conducting a demand survey of the CIM software, I want to collect information on functions of government departments, existing data, existing systems and registration business processes, so that I can provide detailed and accurate demand analysis to ensure software development.

4.7 City management using city brain

CIM-US-CBR-01: As an economy manager of local government and administrations, when I am taking measures for economic development, I want to monitor real-time economic operation state and analyse the influence factors, so that I take correct measures to promote economic development.

CIM-US-CBR-02: As a market manager of local government and administrations, when I am carrying out the market supervision, I want to know about market access efficiency, market activity, the operation of enterprise credit supervision system and administrative penalty events, so that I can maintain good market order, fair market competition.

CIM-US-CBR-03: As a population manager of local government and administrations, when I am carrying out social management and maintaining social stability, I want to make statistics of the number of the population, streets, and communities, so that I can take measures for promoting the coordinated development of population, resources, economy and environment.

CIM-US-CBR-04: As a city safety manager of local government and administrations, when I am carrying out social management and maintaining social stability, I want to monitor the sources of urban security risks, so that I can find the hidden danger and reduce the incidence and harm of safety accidents.

CIM-US-CBR-05: As a disaster and emergency manager of local government and administrations, when I am carrying out social management and maintaining social stability, I want to take immediate action and be collaborative with other departments when there is an emergency event, such as fire, earthquake, and coronavirus disease 2019 (COVID-19), so that I can minimize the damage and loss.

CIM-US-CBR-06: As a public resource manager of the local government and administrations, when I am making plans for public resource construction and providing public service, I want to know the distribution of education resources, land resources, medical resources and tourism resources, the employment situation, so that I can promote the balanced development of public resources and solve the problem of unemployment.

CIM-US-CBR-07: As an environment manager of the local government and administrations, when I am governing environmental pollution, I want to monitor the real-time quality of air, water and acoustic, also the noise, ecological garden construction, solid waste treatment and industrial dust, so that I can find out the cause and the location of the pollution, deal with the pollution in time, draw up environmental protection system, publish air quality forecast to citizens and remind them to arrange their travelling.

CIM-US-CBR-08: As a public appeal manager of the local government and administrations, when I am dealing with the public appeals, I want to make statistics and classification of the issues that concern the public, find out the top five of their appeals, find out the temporal and spatial distribution of the appeals, check the government's processing efficiency and results, so that I can solve in a timely manner the hot and difficult problems that concern the public and enhance the public's sense of happiness and satisfaction.

CIM-US-CBR-09: As a financial supplier/investor, when I am conducting an investment on industry, such as education, medical care, I want to have a better understanding of the current situation and problems of the industry, so that I can get a return.

CIM-US-CBR-10: As an academic researcher, when I am doing research on city management, I want to collect, count, and analyse data from multiple dimensions such as time and space, so that I can find the problems existing in the current urban management, make deeper innovation and propose solutions.

CIM-US-CBR-11: As a CEO, when I am registering one company, I want to know the consumer market, foreign trade, and the overall business environment, so that I can select one registered address with more innovative and dynamic industrial environment and make decisions on the business scope.

CIM-US-CBR-12: As a citizen, when I am buying a house, I want to know the distribution of educational and medical resources, so that I can select one community surrounded by good educational and medical resources and enjoy convenient life.

CIM-US-CBR-13: As a citizen, when I am making travelling plan for the holidays, I want to know the visitor flows at the scenic spots, so that I can make optimal travelling schedule for visiting different scenic spots and bypass periods of high visitor flows.

4.8 Heritage preservation and revitalization

CIM-US-HPR-01: As an urban planner, when I am developing plans for a historical street, I want to access large amount of planning relevant data and current plans which are related to heritage preservation, so that I can organize and analyse the data in a way that helps me to understand its relevance to the planning.

CIM-US-HPR-02: As an urban planner, when I am developing plans for the historical district, I want to be able to easily aggregate and analyse that data without needing high level data analyst skills, so that I can make precise estimation and simulation on specific themes which includes but is not limited to population growths, housing, and traffic needs for the historical district planning.

CIM-US-HPR-03: As an urban planner, when I am developing plans for a historical street, I want to communicate with different stakeholders and collect their comments, so that I can provide a historical preservation plan which can enable the different stakeholders to have a better life and employment in the historical district and increase its sustainability.

CIM-US-HPR-04: As an urban planner, when I am planning to divide the heritage area into active area and buffer area, I want to access the relevant data and information and set a scope which is not planned in detail, so that I can make sure that the area would not be destroyed, and revitalization would become more flexible during the process of construction.

CIM-US-HPR-05: As an urban planner, when I am collecting comments from different stakeholders, I want to provide a three-dimensional (3D) visualization of the planning concept and details, so that I can help different stakeholders to understand the picture of heritage preservation.

CIM-US-HPR-06: As an urban planner, when I am collecting comments from different stakeholders, I want to make it easy for people to understand the benefits of the plans, so that it can attract different people to move to the historical district.

CIM-US-HPR-07: As a real estate developer, when I am making a decision to submit a tender for development programme, I want to understand relevant plans which include regulatory constructive detailed planning, master planning and land space planning, so that I can maximize the benefit and minimize risk for the company.

CIM-US-HPR-08: As a real estate developer, when I am making a decision to submit a tender for development programme, I want to understand the buildings and surroundings in the historical district and know whether there are any other facilities that will be provided that may add to the value to the building, such as convenient transport system, so that I can access whether the heritage area is worth investment and maximize the benefit and minimize risk for the company.

CIM-US-HPR-09: As a real estate developer, when I want to submit a planning for the land use, I want to know the scope of land through a 3D model planning which is allowed to develop, so that I can avoid making mistakes about top planning and reduce the risk.

CIM-US-HPR-10: As a real estate developer, when I want to submit a planning for the land use, I want to understand the requirements of buildings in the heritage district, which include style, quality, quantity and the buildings which are allowed to develop, so that I can maximize the benefit and minimize risk for the company.

CIM-US-HPR-11: As a project scheme designer, when I am investigating the current situation, I want to access the 3D model of current historical districts, which includes spatial data and attribute data, so that I can grasp the whole spatial layout of heritage district and it is easy to integrate and analyse the existing problems.

CIM-US-HPR-12: As a project scheme designer, when I am investigating the current situation, I want to collect the information about the owner of historical building and land (property information, family member, building type, etc.), so that I can grasp the whole spatial layout of heritage district and it is easy to integrate and analyse the existing problems.

CIM-US-HPR-13: As a project scheme designer, when I am investigating the current situation, I want to build a database of historical buildings of districts which includes spatial data, attribute data and relevant data and information, so that I can carry out an effective management and it is helpful for restoration and renovation of historic buildings.

CIM-US-HPR-14: As a project scheme designer, when I analyse the current problems of historical districts, I want to access the data of social network in the historical district, which includes the type of family, demographic structure, the type of residents (owner or tenant), etc., so that I can grasp the social structure, provide evidence for revitalization design, and make it more effective.

CIM-US-HPR-15: As a project scheme designer, when I analyse the current problems of historical districts, I want to use 3D modelling platform to make spatial analysis about the historical district (road network, scope of infrastructure services, etc. and the relation of historical district and near area, such as green land system, transport system, etc.), so that I can find out the real problems about infrastructure services and make direct design and grasp the regional spatial relationship to provide an evidence for revitalization design and make it more effective.

CIM-US-HPR-16: As a project scheme designer, when I am making a design of space layout, I want to use a 3D model which includes spatial attribution and other attribution to make several theme space layout systems, so that I can make a design more effectively and systematically.

CIM-US-HPR-17: As a project scheme designer, when I am making the final decision of project scheme, I want to collect the comments of different stakeholders, which include general public, different government departments and so on, so that I can promote the current design.

CIM-US-HPR-18: As a local business owner, when I am conducting an investment on heritage revitalization, I want to have a better understanding of the current situation and problems of the heritage, so that I can maximize benefits.

CIM-US-HPR-19: As an academic researcher, when I am conducting the research about heritage preservation and revitalization in the area, I want to collect, count, and analyse data about economy, education, medical care, traffic and environment from multiple dimensions such as time and space, so that I can have a better understanding of the current situation and problems of local heritage, make deeper innovation of management model to assist the government and management department to take scientific and effective measures for heritage management.

CIM-US-HPR-20: As a local business owner, when I am asked for comments on the historical district planning, I want to know whether this historical district might be suitable for me to move my business to, so that I can see if it is relevant for me to comment on the proposals.

CIM-US-HPR-21: As a nonlocal business owner, when I am making decision to move the studio to the historical district, I want to know the position and function of the historical district, type of residents, buildings and facilities which will be in the historical district, so that I can evaluate the development potential and prospect of the historical district and ensure maximum profit.

CIM-US-HPR-22: As a construction practitioner, when I am conducting the daily management, I want to know the planning of historical district and space layout, so that I can grasp overall situation and make suitable management adjustment.

CIM-US-HPR-23: As a construction practitioner, when I am conducting the daily management, I want to have a system which can monitor the infrastructure and send a report if it is wrong, so that I can solve the problems in time and reduce the trouble which problems bring to the residents.

CIM-US-HPR-24: As a construction practitioner, when I am conducting the daily management, I want to access resident's basic information, so that I can grasp overall situation and make suitable management adjustment.

CIM-US-HPR-25: As a local community member, when I am aware that there will be a preservation and revitalization planning in my community, I want to know about relevant preservation and revitalization planning and present my comments according to the fact, so that I can protect the life surroundings and relevant custom profits.

CIM-US-HPR-26: As a nonlocal community member who is going to move into the historical district, when I am aware that there will be a preservation and revitalization planning in the historical district, I want to understand the planning and present my comments, so that I can select the proper community and real estate for the family.

CIM-US-HPR-27: As a nonlocal community member, when I am asked for comments on the historical district planning, I want to know the heritage preservation and revitalization planning, so that I can present my comments combined with the real visiting experience.

CIM-US-HPR-28: As a nonlocal community member, when I am going to the historical district for visiting, I want to know a suitable route for visiting according to visiting time and points of interest, which includes heritage building, rest place, and shop, so that I can have a high-quality visit experience and know the district deeply.

CIM-US-HPR-29: As a construction project approval manager, when I am putting the historical district on exhibition for comments, I want to display the plan multi-dimensionally for general public, so that I can be sure that the general public make informed comments on the plans, and I can make the final decision knowing what the result will be.

4.9 Transportation infrastructure planning

CIM-US-TIP-01: As an official of transport infrastructure planning, when I am to build transport links for economic development, I want to understand the impacts of infrastructure development on net-zero, so that I take correct measures to mitigate the development.

CIM-US-TIP-02: As an official of transport infrastructure planning, when I am to build transport links for economic development, I want to understand the available data and relevant technology, so that I take correct measures to mitigate the development.

CIM-US-TIP-03: As an official of transport infrastructure planning, when I am to build transport links for economic development, I want to understand the new travelling possibilities, so that I take correct measures to mitigate the development.

CIM-US-TIP-04: As an official of transport infrastructure planning, when I am to build transport links for economic development, I want to understand the overall net-zero strategy and implementation plan, so that I take correct measures to mitigate the development.

CIM-US-TIP-05: As an official of transport infrastructure planning, when I am to build transport links for economic development, I want to involve public in modelling and decision making, so that I take correct measures to mitigate the development.

CIM-US-TIP-06: As a private infrastructure developer, when I am to build transport links, I want to understand the available data and relevant technology, so that I take correct measures to mitigate the development.

CIM-US-TIP-07: As a private infrastructure developer, when developing new facilities, I want to understand the overall net-zero strategy and implementation plan, so that I take correct measures to mitigate the development.

CIM-US-TIP-08: As an official of environmental authorities, when I am to see transport infrastructure developments, I want to understand the impacts created, so that I take correct measures to mitigate the development.

CIM-US-TIP-09: As an official of environmental authorities, when I am to see transport infrastructure developments, I want to understand the impacts created by new travelling possibilities, so that I take correct measures to mitigate the development.

CIM-US-TIP-10: As an official of environmental authorities, when I am to see transport infrastructure developments, I want to understand the impacts created by new transport infrastructure, so that I can see if the correct approach is being adopted or not.

CIM-US-TIP-11: As a utility services provider, when I am to see transport infrastructure developments, I want to understand the impacts created, so that I take correct measures to mitigate the development.

CIM-US-TIP-12: As a real estate developer, when I am submitting the land bidding document, I want to understand the impacts created by the existing and new transport infrastructure, so that I can estimate a price of the land.

CIM-US-TIP-13: As a citizen, when I know there will be new transport links for economic development, I want to be involved in the decision making, so that I influence the correct measures to mitigate the development.

CIM-US-TIP-14: As an official in United Nations – United Nations Framework Convention on Climate Change, when I am to coordinate the UN sustainable development goal, I want to enable more understanding on the technical terms of the overall net-zero strategy and implementation plan, so that I can help to direct measures to mitigate the development.

4.10 Traffic management

CIM-US-TRM-01: As a traffic police, when I am deployed to deal with a traffic accident, I want to know the location of traffic accidents, so that I can quickly reach the accident site and handle traffic accidents in time.

CIM-US-TRM-02: As a traffic police, when I am assigned to make a preliminary judgment on a traffic accident, I want to gather information about this on-site accident from photos and videos, in which how, when, where, why this accident happened and who was involved will be shown, so that I can make a preliminary traffic accident liability confirmation.

CIM-US-TRM-03: As a traffic police, when I am asked to promote traffic safety for the citizen, I want to publicize the result of traffic accidents and notify bad influences to the parties involved in the accident, so that I can educate the citizen about the dangers of traffic accidents and warn the public to obey traffic rules.

CIM-US-TRM-04: As a traffic police, when I hear the traffic offender escaped, I want to collect the information of the offender through traffic video surveillance and analyses the escape route, so that I can arrest him or her as soon as possible.

CIM-US-TRM-05: As a traffic police, when I am deployed to deal with traffic jams, I want to know the location of traffic jams and the arrival route, so that I can rush to the traffic jam area as soon as possible for manual traffic command.

CIM-US-TRM-06: As a traffic police, when I am deployed to ensure the smooth traffic ahead of time, I want to transmit information about the traffic jam area and the surrounding potentially congested roads in real time, so that I can avoid and reduce the occurrence of safety accidents to the greatest extent.

CIM-US-TRM-07: As a traffic command centre manager, when I am notified of an emergency traffic accident, I want to know the location of traffic accidents, the distribution of traffic police around and the current traffic situation, so that I can inform traffic police who are near the accident site, and provide accident information and efficient travel routes to respond to the emergency.

CIM-US-TRM-08: As a head of traffic management department, when I am required to improve traffic safety, I want to collect and analyse historical traffic accident location, weather, time, and event information without high-level technical skills, so that I can know the causes and characteristics of traffic accidents and formulate targeted traffic improvement plans.

CIM-US-TRM-09: As a head of traffic management department, when I am required to optimize a route for public rescue facilities to carry out rescue, I want to collect existing road traffic information, including the current road network, traffic conditions, distribution of road traffic facilities, and road traffic flow, so that I can fully provide the best routes.

CIM-US-TRM-10: As a traffic management planner, when I need to consider whether the construction of existing traffic facilities is unreasonable, I want to collect the basic information of the facilities, surrounding land use, building types, permanent population, and permanent population travel patterns, so that I can update and arrange new facilities in more reasonable places.

CIM-US-TRM-11: As a traffic management planner, when I submit an application for construction of new transportation facilities, I want to use analytical models to simulate the potential impact of new transportation facilities on the surrounding land, buildings and population without high-level technical skills, so that I can adjust the construction of transportation facilities to meet the needs of transportation development.

CIM-US-TRM-12: As a traffic management planner, when I am required to check the operation status of transportation facilities, I want to collect comments on construction plan from different stakeholders and deploy corresponding smart devices on them, so that I can obtain the real opinion of the citizen and adjust the construction of transportation facilities to meet people's travel needs.

CIM-US-TRM-13: As a traffic management planner, when I asked to compare the best construction plan of the new transportation facilities, I want to view different transportation construction plans within the same scope in a split screen, and compare the site selection, route direction, and technical and economic indicators of the plans, so that I can quantify the advantages and disadvantages of each plan to choose the best solution.

CIM-US-TRM-14: As a local community member, when I am going to plan the route, I want to know the real-time traffic flow on my current travel route and other feasible travel routes and commute time, so that I can adjust my travel route in real time and reduce commuting time.

CIM-US-TRM-15: As a local community member, when I drive, I want to know the location of the parking lot at the destination, so that I can avoid the penalty of illegal parking.

CIM-US-TRM-16: As a local community member, when I take a bus, I want to know where the bus stop is, which bus will take me to my destination and how long until the next bus arrives, so that I can reduce the waiting time, take the right bus, and have a good travel experience.

CIM-US-TRM-17: As a local community member, when I travel with shared bicycles, I want to know the parking area, driving range of shared bicycles and cycling route, so that I can quickly find usable shared bicycles and travel safely and compliantly.

CIM-S-TRM-18: As a nonlocal community member, when I am visiting the city, I want to know the location of tourist attractions and how to get there, so that I can choose a suitable travel method.

CIM-US-TRM-19: As a bus company chief executive, when I optimize the bus operation model, I want to collect information such as bus travel demand, peak and trough periods, and the distribution of bus trip, so that I can reasonably allocate public transportation resources and reduce operating costs.

CIM-US-TRM-20: As a bus operations manager, when I supervise the bus operation, I want to collect the bus location and video surveillance information in real time, so that I can make timely decisions in the event of a bus emergency.

CIM-US-TRM-21: As a bus operations manager, when I provide bus services, I want to collect real-time bus location, running speed and stop location, so that I can provide real-time and reliable bus travel guidance for bus travellers.

CIM-US-TRM-22: As a technician in traffic law enforcement department, when I am asked to cooperate with traffic police or traffic command centre manager, I want to analyse the video or image information of traffic illegal behaviour and potential escape routes, so that I can provide accurate information of traffic offenders and vehicles, as well as provide traffic police with real-time technical support.

CIM-US-TRM-23: As a traffic facility maintainer, when I am asked to supervise the operation status of traffic facilities, I want to collect real-time operation data of all traffic equipment, and give early warning and location identification of faulty equipment, so that I can repair faulty equipment in time.

CIM-US-TRM-24: As a bus company planner, when I am asked to develop a bus route planning according to the company`s operating strategy, I want to analyse the rationality of bus stops and route planning, so that I can adjust bus planning route in a timely manner to generate a reasonable bus plan.

4.11 Water management

CIM-US-WAM-01: As a water resources utilization planner, when I develop a water resources utilization planning, I want to know the current distribution and volume of water resources such as surface water, groundwater, rivers and lakes, precipitation, water conservancy facilities, so that I can fully understand the current situation of water resources.

CIM-US-WAM-02: As a water resources utilization planner, when I need to look for problems in current water resource utilization planning, I want to analyse the collected information efficiently and visually without high-level technical skills, so that I can clearly find the current questions and the spatial location of the problems.

CIM-US-WAM-03: As a water resources utilization planner, when I implement a water resource utilization plan, I want to use the data analysis model to analyse the rationality and feasibility of the planning, so that I can get a reasonable and effective planning, which can guide the city's future water use.

CIM-US-WAM-04: As a water resources utilization planner, when I need to check whether the water resource utilization plan is suitable, I want to assess the impact and potential results of the planning, so that I can properly adjust the water resource utilization plan in time.

CIM-US-WAM-05: As a flood control dispatcher, when I am required to reduce the impact of flooding, I want to collect historical flood information, such as precipitation, flooding location, damage scope and others, so that I can know the location of flood-prone areas and take effective improvement measures.

CIM-US-WAM-06: As a flood control dispatcher, when I should prepare in advance to avoid floods, I want to receive real-time warning messages of river and lake water levels, notifications of abnormal weather, so that I can take measures to prevent flooding in advance.

CIM-US-WAM-07: As a flood control dispatcher, when I am making contingency plans for preventing and mitigating natural disasters, I want to generate various visual flood disaster solutions based on influencing factors, without high-level technical skills, so that I can choose a more reasonable and effective solution to reduce the impact of flooding.

CIM-US-WAM-08: As a water resources utilization planner, when I supervise water supply and water quality, I want to supervise the development and utilization of water resources in the water source protection area in real time, so as I can detect activities that can harm the water environment in time and notify law enforcement officers to stop these activities.

CIM-US-WAM-09: As a water conservancy project construction management personnel, when I supervise the construction of water conservancy projects, I want to collect construction procedures, materials, and equipment of water conservancy projects, so that I can get a safe and qualified water conservancy engineering facility.

CIM-US-WAM-10: As a water law enforcement inspector, when I am responsible for monitoring warning information in a timely manner, I want to use video surveillance to collect information on the location, person, and event of water affair violations, and accurately locate it in the digital space, so that I can reach the corresponding area in time to carry out precise law enforcement.

CIM-US-WAM-11: As a water law enforcement manager, when I am deployed to deal with water affair violations, I want to know the distribution of law enforcement officers in and around the area where the illegal act is located, so that I can push illegal law enforcement tasks to nearby law enforcement officers' mobile devices.

CIM-US-WAM-12: As a water law enforcement manager, when I am asked to improve the efficiency of law enforcement, I want to analyse the key locations where high frequency violations occur based on historical water law enforcement records, so that I can implement close supervision and law enforcement in key areas.

CIM-US-WAM-13: As a project progress manager of water engineering construction company, when I manage the construction progress of the project, I want to collect materials, equipment, and personnel deployment information on construction sites, so that I can control the progress of construction projects in real time.

CIM-US-WAM-14: As a project progress manager of water engineering construction company, when I am asked to adjust the construction period of the construction project, I want to simulate the subsequent construction plan based on the existing construction personnel, materials, equipment and construction progress records, so that I can judge in advance whether the project can be delivered on schedule.

CIM-US-WAM-15: As a project progress manager of water engineering construction company, when I am asked to prepare a changed construction plan, I want to calculate the number of personnel, equipment, and materials required for the construction schedule change based on the construction design model, so that I can carry out preparations to meet the changing requirements of construction schedule.

CIM-US-WAM-16: As a project safety officer of water engineering construction company, when I am asked to ensure safety, I want to analyse the potential risk areas during the construction process based on the construction design model, so that I can take protection measures in advance to ensure construction safety.

CIM-US-WAM-17: As a project safety officer of water engineering construction company, when I need to implement safety codes of conduct, I want to simulate and generate a safety plan based on the construction design model, so that I can guide construction workers to carry out construction safely.

CIM-US-WAM-18: As a director of water works, when I manage the water works, I want to rely on the sensing equipment to record the daily water supply, daily water intake, water quality monitoring data and so on, so that I can have a comprehensive understanding of the water treatment capacity and supply capacity of the water works.

CIM-US-WAM-19: As a water intake supervisor, when I find the water quality has changed, I want to know the location of the corresponding water intake, the flow direction of rivers or lakes and relevant videos or photos, so that I can find the underlying causes of water quality changes.

CIM-US-WAM-20: As a director of water works, when I want to do water plan management, I want to locate the main water supply units and record the corresponding amount, so that I can adjust the operation plan of the water works according to the water supply scope and capacity.

CIM-US-WAM-21: As a citizen, when I receive a flood warning, I want to know whether the area where I live will be affected by floods and the severity of the floods, so that I can prepare for flood prevention in advance or move out of the area where I live now.

CIM-US-WAM-22: As a citizen, when I know there is a water conservancy project construction plan around the living area, I want to evaluate the impact of water conservancy project construction planning on residential areas and environmental quality, so that I can reasonably express my opinions on water conservancy projects during the planning stage.

CIM-US-WAM-23: As a citizen, when I find illegal behaviour in the nearby living area, I want to report the violations and locations I saw, so that I can protect the water environment where I live.

CIM-US-WAM-24: As a river and lake manager, when I am asked to protect the ecology of rivers and lakes, I want to monitor the relevant drainage outlets, so that I can track down the relevant responsible object based on the diffusion of water pollutants.

CIM-US-WAM-25: As a river and lake manager, when I am asked to supervise the changes of the river shoreline, I want to query the changes of the river shoreline at different times and simulate the future change trend of the river shoreline with analysis tools, so that I can take corresponding flood prevention measures or formulate river shoreline utilization plans.

CIM-US-WAM-26: As an engineering quality inspector of water engineering construction company, when I am asked to manage the project quality during the construction process, I want to record the project quality issues collected on site, so that I can check the project quality issues at the completion acceptance stage.

CIM-US-WAM-27: As an engineering quality inspector of water engineering construction company, when I am asked to check the completion quality of the water conservancy project, I want to review the completion quality according to the construction process quality control model, so that I can efficiently judge whether the project met the project quality requirements and put it into use.

4.12 Smart census project

CIM-US-SCP-01: As an official of census statistical department, when I am to develop a numerical profile of human capital of a nation, I want to understand the standard of the technology or method, so that I take correct measures to encourage the development of smart census.

CIM-US-SCP-02: As an official of census statistical department, when I am to develop a numerical profile of human capital of a nation, I want to ensure the confidentiality of the technology or method, so that I take correct measures to encourage the development of smart census.

CIM-US-SCP-03: As an official of census statistical department, when I am to develop a numerical profile of human capital of a nation, I want to ensure the improved frequency of the smart census, so that I can take timely measures to encourage the right amount of measures or developments and assistance.

CIM-US-SCP-04: As an official of census statistical department, when I am to develop a numerical profile of human capital of a nation, I want to ensure the smart census meets a specified technical standard, so that I can trust the output.

CIM-US-SCP-05: As an official of census statistical department, when I am to develop a numerical profile of human capital of a nation, I want to know if there is any automated coding procedure on the smart census which meets a specified technical standard, so that I know I have followed the standard specification.

CIM-US-SCP-06: As an official of census statistical department, when I am to develop a numerical profile of human capital of a nation, I want to know if there is any standardized way in engaging with the hard-to-count population, so that I know I have followed the standard specification.

CIM-US-SCP-07: As an official of public development agency, when I am to build schools, hospitals, doing land-use planning for economic development, I want to be given an accurate and reliable assessment, so that I take correct measures to plan the development.

CIM-US-SCP-08: As an official of public development agency, when I am to use the smart census data, I want to know if the processing is done in accordance with a standardized coded assessment, so that I can have quick data output from the smart census

CIM-US-SCP-09: As an official of public development agency, when I am to use the smart census data, I want to find relevant information and discover resources, so that I can help organize electronic resources, provide digital resources.

CIM-US-SCP-10: As a smart cities/net-zero businesses owner, when I am to build smart capabilities to meet the current demands, I want to understand the overall city condition and plan, so that I take correct measures to help the development.

CIM-US-SCP-11: As a smart cities/net-zero businesses owner, when I am to build smart capabilities to meet the current demands, I want to ensure more technical assurance and anti-corruption through providing more standardized controlled and auditable records of actions, so that I can take correct measures in business decision.

CIM-US-SCP-12: As a manager of a public transportation company, when I am to cater to the current demands, I want to understand where the current and immediate future population mobility trend is and where any improvements should be, so that I can take correct measures in business decision.

4.13 Urban underground pipeline management based on data lake

CIM-US-UPM-01: As a pipeline design supervisor of the municipal commission of urban management department, when I am designing pipeline system, I want to know the current distribution of pipelines, so that I can make rational designing scheme.

CIM-US-UPM-02: As a pipeline construction supervisor of the municipal commission of urban management department, when I am making plan for pipeline construction and reconstruction, I want to know the other engineering construction plan, such as underground space, road traffic, civil air defence and subway, so that I can make synchronized construction plan and to avoid "road zippers".

CIM-US-UPM-03: As a pipeline operation supervisor of the municipal commission of urban management department, when I am supervising pipeline operation, I want to know the basic data, maintenance data and the operating state for all kinds of pipelines, so that I can know about the operation state of pipelines and ensure the safe operation of pipelines.

CIM-US-UPM-04: As a pipeline construction manager of the pipeline construction and operation company, when I am carrying out pipeline construction, I want to submit the pipeline design scheme, so that I can get permission from municipal commission of urban management.

CIM-US-UPM-05: As a pipeline operation manager of the pipeline construction and operation company, when I am implementing pipeline patrol, I want to monitor pipeline operating state in real time, visually and intuitively, so that I can analyse pipeline operating state more efficiently and accurately.

CIM-US-UPM-06: As a pipeline safety manager of the pipeline construction and operation company, when I am implementing pipeline hidden danger investigation, I want to simulate and analyse pipeline operating state, so that I can find the potential safety hazards.

CIM-US-UPM-07: As a pipeline lifecycle manager of the pipeline construction and operation company, when I am implementing pipeline lifecycle management, I want to collect and integrate all the data for pipelines from planning, designing, constructing, maintaining and scrapping, so that I can access the data for later use.

CIM-US-UPM-08: As a pipeline accident manager of the pipeline construction and operation company, when I am dealing with pipeline accidents, I want to simulate and analyse pipeline operating state, so that I can quickly and accurately determine accident location and find the cause.

CIM-US-UPM-09: As a pipeline accident manager of the pipeline construction and operation company, when I am dealing with a complex pipeline accident, I want to communicate and coordinate with other engineering construction company, so that I can quickly and accurately determine accident location and find the cause.

CIM-US-UPM-10: As a civil engineering construction manager of the engineering construction company, when I am constructing subway, road, civil air defence and so on, I want to browse and review pipeline construction drawings and know the distribution of the pipelines, so that I can avoid damaging the pipelines.

CIM-US-UPM-11: As a citizen, when I am reconstructing the pipeline for daily life, I want to know about the pipeline diagram, so that I can avoid damaging the pipelines and avoid causing trouble to the neighbours.

CIM-US-UPM-12: As a citizen, when I find actions endangering pipeline safety, I want to report to the municipal commission of urban management, so that I can protect the pipeline.

4.14 Emergency management and rescue

CIM-US-EMR-01: As an inspect officer, when conducting real-time inspections of the site, I want to provide feedback to the CIM platform, so that the commanders can catch the on-site situation on time.

CIM-US-EMR-02: As an emergency response officer, when finding the initial fire situation on site, I want to report the initial fire situation to the CIM platform in time so that I can help the experts in the emergency field to predict the fire trend.

CIM-US-EMR-03: As a commander, when there is an emergency rescue, I want to understand the hidden danger situation of the emergency rescue site, so that I can schedule the emergency rescue team and equipment to be insured.

CIM-US-EMR-04: As a member of the emergency rescue team, when I use the CIM platform, I want the CIM platform to be easy-to-understand, so that I can usually use the platform as a practical and popular tool to finish my work.

CIM-US-EMR-05: As an emergency management and rescue specialist, when the emergency happens, I want to predict the disaster trend of the emergency rescue site with the on-site relevant data provided by CIM platform, so that I can help the rescue team to generate corresponding rescue plan.

CIM-US-EMR-06: As a business owner, when planning a new security area, I want to obtain a large amount of emergency-related data and analyse it, so that I can facilitate the correlation between data and planning.

CIM-US-EMR-07: As a business owner, when making emergency rescue plans, I want to model security buildings and rescue points, so that different types of models and simulations can be conducted for emergency management and rescue.

CIM-US-EMR-08: As a business owner, when presenting emergency plans to customers, I want to provide a 3D visual interface to express planning concepts and details, so that I can ensure that different stakeholders can understand the emergency rescue plan easily.

CIM-US-EMR-09: As a citizen, when participating in large-scale activities, I want to learn the escape routes and methods through CIM platform, so that I can minimize the risk of suffering the disaster.

5 Use cases collection and database

5.1 General

This document addresses the CIM use cases in the following application areas (AAs):

1) new town planning;
2) three-dimensional visualization of property and land administration;
3) construction approval management;
4) project management during construction;
5) real estate registration management;
6) city management using city brain;
7) heritage preservation and revitalization;
8) transportation infrastructure planning;
9) traffic management;
10) water management;
11) smart census project;
12) urban underground pipeline management based on data lake; and
13) emergency management and rescue.

These use cases are addressed in 5.2 to 5.14, which are structured as follows: i) use cases; ii) use case analysis; iii) requirements for the standards; and iv) related document.

Each use case follows the IEC short use case template (IEC TR 62559-1:2019, IEC 62559-2:2015 and IEC 62559-3:2017), which includes the name of the use case, scope/objective, narrative, and list of actors. The actors include human and non-human actors. The main stakeholder is the first actor in each use case.

5.2 New town planning

5.2.1 Use cases

See Table 1.

Table 1 – The use cases of applying CIM in new town planning

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-NTP-01	A large amount of data exchange	To exchange a large amount of data in multiple formats	This use case describes how different government departments can upload different types of data, and urban planners can access these data by using CIM platform. The new town planning needs to collect data from multiple different departments, such as water, transport, civil engineering, health, travel, etc. Different government departments can upload their data according to the requirements in one CIM platform. The urban planner can access the data with permission.	Urban planner, economy manager, market manager, population manager, CIM platform developer, city safety manager, disaster and emergency manager, public resource manager, environment manager, CIM platform, CIM online platform, data storage facility, CIM platform web server

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-NTP-02	User-friendly modelling platform	To provide a user-friendly and skill-free modelling platform for estimation and simulation	This use case describes the skills required to use the CIM platform. Different types of users, including urban planners, will use the CIM platform. They possibly do not have the skills of programming, modelling and simulation. The CIM platform should provide a user-friendly and skill-free interface for all types of users.	Urban planner, CIM platform and software developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-NTP-03	3D visualization of the planning project	To display the planning in a 3D format and help all types of stakeholders to understand the project	This use case describes how urban planners use CIM to visualize the planning in 3D format. It is difficult for urban planners to envision a smart future for fast-growing cities using simple two-dimensional maps. The CIM platform can integrate different types of data and displace them in 3D format. This platform provides a dynamic database which integrates the land use, building use, and height with a floor space index, water distribution network, wastewater network, transport network, etc.	Urban planner, CIM platform and software developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-NTP-04	Modelling and simulation	To make the simulation of different scenarios	This use case describes how urban planners use CIM to make the simulation of different scenarios. Urban planners can use CIM platform to make the simulation of different scenarios. For example, urban planners establish models to estimate the demands of housing, transport, public space, health facilities, etc. according to a different level of population growth rate. The CIM platform should also provide the flexibility to revise the parameters and have the new outcomes efficiently.	Urban planner, citizen, CIM platform developer, CIM platform and software developer, data storage facility, CIM platform web server
CIM-UC-NTP-05	Making the planning easy to understand	To explain and display the planning in way easy to understand	This use case describes how urban planners use CIM to explain and display the planning for all types of stakeholders. The general public possibly do not have the professional knowledge and skills to understand the planning. However, urban planners should use their technologies to explain the planning in a way easy to understand and display the planning to all types of stakeholders. The CIM platform should provide the function of displaying in a simplified way.	Urban planner, the citizen, CIM platform and software developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-NTP-06	Including the function of comment	To provide a comment function	This use case describes the requirement of the comment function of the CIM platform. Urban planners should communicate with different stakeholders, which include the general public, companies, authorities, organizations which have their specific interest, different government departments, etc. at a different stage of the planning projects. They need to present the planning and collect comments from different stakeholders. The web CIM platform can help almost all types of stakeholders to view and comment on the planning.	Urban planner, citizen, CIM platform and software developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-NTP-07	Data/ information integration	To integrate different types of information in one platform and different types of stakeholders can access them	This use case describes that the developers use the CIM platform to access multiple types of population data and use the data for analysis. Developers need to obtain more information about the types and numbers of the existing and surrounding population, as well as their socioeconomic status. This is helpful to calculate how much the families could afford for a department. They will make the optimal plan when submitting a tender for the land use purchasing programmes.	Real estate developer, urban planner, CIM platform and software developer, CIM online platform, data storage facility, CIM platform web server

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-NTP-08	Providing information on civil facilities	To provide information on civil facilities on the planning	This use case describes that the developers use the CIM platform to access the data of civil facilities on the planning and use the data for analysis. The development of new and upgraded transport infrastructure, health and community facilities, schools and other livelihood facilities can drive the value of the commercial buildings as well as neighbourhood residential property. Developers need to have the information of all the existing and coming civil facilities and calculate their impacts on the value of the property.	Real estate developer, urban planner, CIM platform and software developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-NTP-09	Communication between urban planning and development planning for a specific land	To communicate between urban planning and development planning for a specific land	This use case describes how the developers use the CIM platform to access the data and requirements of a specific land for development. The developer can obtain the data of the urban planning in CIM platform for their preparing, organizing and submitting a development request for a specific land. The developer is authorized to edit the CIM platform and add information, especially including the building information modelling (BIM) for the specific land when the request is approved.	Real estate developer, urban planner, CIM platform and software developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-NTP-10	Obtaining the skills to use the CIM platform for development planning	To obtain the skills to use the CIM platform for development planning	This use case describes how the developers obtain the skills to use the CIM platform to make effective planning on land use and present the planning multi-dimensionally. The developer has obtained the data of the urban planning in the CIM platform. The staff is trained to use the CIM.	Real estate developer, urban planner, CIM platform and software developer, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-NTP-11	Commenting on the planning from the perspective of a business owner	To obtain different types of data of the urban planning for commenting on the urban planning from the perspective of business owners	This use case describes how the company CEO obtains different types of data of the urban planning, uses them for analysis and makes comments on the planning. The business owner can represent their willingness to start or move the business in the new town area. Their willingness has impacts on the rental price of the shops and offices in the new town area. A shop owner possibly views a development application for a new and competing business in their business centre differently to a local resident wanting more variety and competition in their local shops.	Business owner, CIM platform and software developer, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-NTP-12	Relocating the business to the new town	To obtain different types of data of the urban planning for decision making to move the company to the new town	This use case describes how the company CEO obtains different types of data of the urban planning, uses them for analysis and makes the decision whether to relocate the business before the new town is developed. Relocating the business refers to moving the office from the existing place to the new town. Relocating the business has financial impacts in both the short term and long term. It is usually not a cheap endeavour to move the office to a new place. The relocation also causes changing leasing payments, utilities, taxes, the wages paid to the employees, the cost of shipping, and other secondary impacts. The decision of relocation also involves the impacts of employees and other stakeholders.	Business owner, CIM platform and software developer, CIM platform, CIM online platform, data storage facility, CIM platform web server

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-NTP-13	Protecting the living environment and habits for existing residents	To understand the new town planning for protecting the original living environment and habits for existing residents	This use case describes how existing residents are involved in the new town planning. The new town planning can meet with a barrage of criticism, some of which is worthy of wider public discussion. The existing residents in the new town area are a group of very important stakeholders. They want to understand the new town planning by using the skill-free CIM platform for the general public, estimate the impacts on their existing living environment and habits, make comments on the planning, protect their benefits.	Local community member, urban planner, CIM platform and software developer, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-NTP-14	Being relevant for making comments	To make the decision of making comments on the new town planning	This use case describes how the citizens who are living outside of the new town are involved the new town planning. The citizens who are living outside of the new town are also a group of important stakeholders in the new town planning. They are requested to comment on the planning. For the group of residents, who find the possibility to move to the new town, they will have strong interests and intention to respond to the planning.	Nonlocal community member, urban planner, CIM platform and software developer, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-NTP-15	Relocating the home to the new town	To obtain different types of data of the urban planning for decision making to move home to the new town	This use case describes how the citizen who is living outside of the new town obtains different types of data of the urban planning, uses them for analysis and makes the decision whether to relocate home before the new town is developed. The household needs to consider the housing, employment opportunities, commuting, education, health care facilities, and other neighbourhood facilities before they can decide to move home to the new town area.	Nonlocal community member, urban planner, CIM platform and software developer, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-NTP-16	Selecting the community for the new home	To understand the new town planning and selecting the community for the new home	This use case describes how the nonlocal community members who are going to move into the new town select their community for the new home. The household needs to consider the housing price, surrounding environment, transport, schools, health care facilities, and other neighbourhood facilities before they can select the community for a new home.	Nonlocal community member, CIM platform and software developer, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-NTP-17	Making comments on the transport facilities	To understand the new town planning and make comments on the transport facilities	This use case describes how the nonlocal community member who is going to move their work into the new town is involved in the new town planning by making comments, especially on the transportation facilities. When the company is relocated to the new town, workers will also move together. Some will move their household together into the new town, and some will not. This depends on the distance and transport facilities. It is much relevant for them to make comments on the new town planning, especially on the transportation facilities for their coming daily commuting.	Nonlocal community member, urban planner, CIM platform and software developer, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-NTP-18	Making the final decision to approve the new town planning	To examine the feedback of different stakeholders and make the final decision to approve the new town planning	This use case describes how the urban planning decision maker obtains the new town planning from the urban planner, displays the plan multi-dimensionally for the general public and makes the final decision to approve the planning. The government will obtain the whole data set of the new town planning. Before the final decision of the new town planning, the government also needs to display the planning for the general public.	Urban planning decision maker, urban planner, CIM platform and software developer, CIM platform, CIM online platform, data storage facility, CIM platform web server

5.2.2 Use case analysis

The application of city information modelling to the new town planning aims to: a) integrate multiple data on one platform; b) conduct simulation on a wide range of themes; c) provide a 3D and timely presentation of the new town planning; d) facilitate the communication between different stakeholders.

The stakeholders of applying CIM to the new town planning include urban planners (primary beneficiary, designer and user), real estate developers (secondary beneficiary, builder), business owners (secondary beneficiary), citizens including local community members and nonlocal community members (tertiary beneficiary) and urban planning decision maker (owner and maintainer). Urban planners play a pivotal role to connect all the other stakeholders.

CIM serves as a giant data hub, central processing unit and communication platform in new town planning. It assists urban planners to collect relevant data from different organizations and government departments, present the planning to important stakeholders and collect comments from them, conduct simulation, adaption and visualization for the data-driven and stakeholder-focused planning output.

Eighteen city information modelling use cases were collected in the application area of new town planning regarding the stakeholders of the urban planner (6 use cases), real estate developer (4 use cases), business owner (2 use cases), local community member (1 use case), nonlocal community member (4 use cases), and urban planning decision maker (1 use case) (Figure 2).

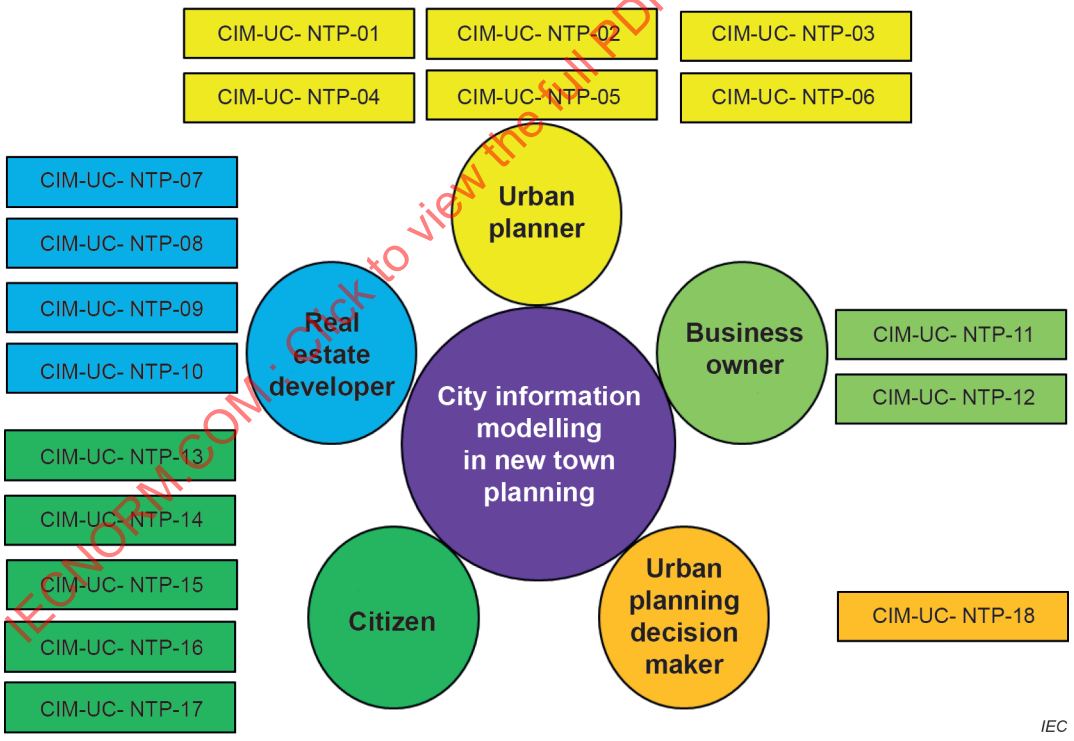


Figure 2 – Structure of use cases of applying city information modelling in new town planning regarding stakeholders

The user stories and use cases serve different needs of applying city information modelling to new town planning (Figure 3): a) different types of new town planning relevant data need to be put into one platform for efficient data query and acquisition (CIM-NS-NTP-01,1 use case); b) different types of models and simulations need to be conducted for different themes of studies in new town planning (CIM-NS-NTP-02, 2 use cases); c)the planning needs to be expressed in an easy-to-understand way (CIM-NS-NTP-03, 4 use cases); d)different stakeholders need to check and comment the new town planning in a user-friendly platform (CIM-NS-NTP-04, 4 use cases); and e)the authorized groups need to acquire, upload, download, and edit the data in the platform without high skill requirement (CIM-NS-NTP-05, 7 use cases).

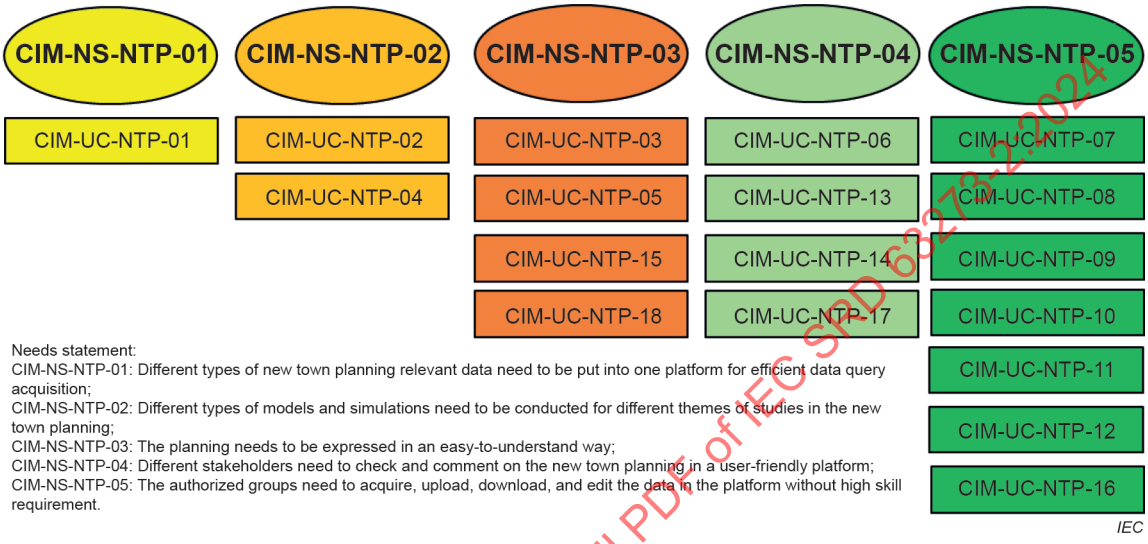


Figure 3 – Structure of use cases of applying city information modelling in new town planning regarding needs statement

5.2.3 Requirements for the standards

The CIM standards when considering its application to new town planning should consist of the requirements of different types of data, which include but are not limited to the format of the data. Moreover, the CIM standards should define different levels of permission and access for different users, which can include but are not limited to level of project administrators, contributors, readers and commenters.

5.2.4 Related documents

- ISO 37166:2022, Smart community infrastructures – Urban data integration framework for smart city planning (SCP)
- Technical guidelines for city information modelling (CIM) basic platform (China)

5.3 Three-dimensional visualization of property and land administration

5.3.1 Use cases

See Table 2.

Table 2 – The use cases of applying CIM in three-dimensional visualization of property and land administration

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-3DV-01	Community engagement and transparency for citizens	To review and anticipate the changes in my communities-built environment	This use case describes how local community members can view the developments that are pending in their community and engage with local governments on supporting or opposing the developments. The impacts or the benefits of the developments are better understood when contextualized in a 3D visualization platform alongside other existing infrastructure elements.	Local community member, CIM online platform
CIM-UC-3DV-02	Community engagement and transparency by local government assessment officers	To support community engagement in built environment and infrastructure developments	This use case describes how local government assessment officers can use data driven decision making whilst also providing community engagement through integrating 3D model objects into a platform of other spatially based data objects for computational analysis and review.	Local government assessment officer, CIM online platform
CIM-UC-3DV-03	Community engagement and transparency by local government assessment officers	Support community engagement in built environment and infrastructure developments	This use case describes local government assessment officers ensuring that local area citizens are engaged and active in shaping their communities-built environment. Supporting the creation of better transparency between government and citizens.	Local government assessment officer, CIM online platform
CIM-UC-3DV-04	Community engagement and transparency by local government assessment officers	To manage the land use and planning instruments in a data driven way	This use case describes how 3D visualization can support experts in key community areas to contribute their knowledge on the potential benefits and risks of new developments.	Local government assessment officer, CIM platform
CIM-UC-3DV-05	Data collection, maintenance, and delivery	To provide spatial and temporal pending and planned infrastructure developments in a digital environment	This use case describes how data maintenance personnel can receive, load, and maintain key development data for the benefit of citizens, government, project scheme designers and local special interest groups.	Platform maintainer, CIM platform
CIM-UC-3DV-06	Accelerate planning assessment and approval	To create a data supply chain for better assessment and approval metrics and validations	This use case describes how project scheme designers can utilize data driven validation, approvals, and public opinions on their developments through 3D model submissions to a 3D visualization platform.	Project scheme designer, CIM platform
CIM-UC-3DV-07	Regulation and validation of infrastructure	To manage the land use and planning instruments in a data driven way	This use case describes how a local government certifier can use data driven analysis through development data and planning instrument data integration and computational analysis.	Local government certifier, CIM platform

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-3DV-08	Community engagement and transparency	Support community engagement in built environment and infrastructure developments	This use case describes how the local government certifier can consider the responses of the public citizen and groups which is facilitated through the online 3D visualization platforms comment and review capabilities.	Local government certifier, CIM platform
CIM-UC-3DV-09	Assessment of impact on regional energy assets	To assess new developments against resiliency measures	This use case describes how developments can impact the coolness and heat factors of an urban environment and how the 3D visualization platform and the connected underlying data of the development can be used to facilitate analysis in this area.	Advocacy and special interest group, CIM platform
CIM-UC-3DV-10	Protection of environmental assets, and liveability (human liveability factors)	To assess new developments against key community assets	This use case describes how developments can impact the human liveability factors of an urban environment and how the 3D visualization platform and the connected underlying data of the development can be used to facilitate analysis in this area.	Advocacy and special interest group, CIM platform
CIM-UC-3DV-11	Protection of environmental assets, and liveability (air quality factors)	To assess new developments against key community assets	This use case describes how developments can impact air quality factors of an urban environment and how the 3D visualization platform and the connected underlying data of the development can be used to facilitate analysis in this area.	Advocacy and special interest group, CIM platform
CIM-UC-3DV-12	Assessment of community member needs and requirements	To assess new developments against key community assets	This use case describes how developments can impact accessibility factors of an urban environment and how the 3D visualization platform and the connected underlying data of the development can be used to facilitate analysis in this area.	Advocacy and special interest group, CIM platform
CIM-UC-3DV-13	Protection of environmental assets, and liveability (wildlife)	To assess new developments against key community assets	This use case describes how developments can impact wildlife within an environment and how the 3D visualization platform and the connected underlying data of the development can be used to facilitate analysis in this area.	Advocacy and special interest group, CIM platform
CIM-UC-3DV-14	Protection of environmental assets, and liveability (plant species)	To assess new developments against key community assets	This use case describes how developments can impact plant species within an environment and how the 3D visualization platform and the connected underlying data of the development can be used to facilitate analysis in this area.	Advocacy and special interest group, CIM platform

5.3.2 Use case analysis

The application of CIM for 3D visualization of development application aims to: a) integrate multiple data on one platform; b) conduct analysis on a wide range of needs; c) provide a 3-dimensional visualization of the new development application; and d) facilitate the review and feedback between different stakeholders.

The stakeholders involved in the application of three-dimensional development application for the purpose of three-dimensional visualization of property and land administration include the local government assessment officer as the primary beneficiary, owner and maintainer of the CIM ecosystem; project scheme designer as the primary beneficiary and builder of the CIM ecosystem; local government certifier as the primary beneficiary and builder of the CIM ecosystem; advocacy and special interest group as secondary beneficiaries and user of the CIM ecosystem; platform maintainer as the tertiary beneficiary and designer and maintainer of the CIM ecosystem; and citizen as the tertiary beneficiary and user of the ecosystem (Figure 4).

In creating a platform and ecosystem for the review and analysis of a 3D development application, various stakeholders and systems of community planning are enhanced and improved. It assists local councils and local assessment officers and certifiers within the council to collect and analyse against city planning instruments and engage with community expertise across several environmental and social conditions relevant to new developments. Enabling a digital thread within the property and construction pipeline of development and the capture of digital data assets, supports the flow of information through gateway checks and approvals and provides downstream utilization of infrastructure data for improving the planning, construction, and maintenance of a built environment (Figure 5).

Fourteen city information modelling use cases were collected in the application area of 3D visualization for development applications.

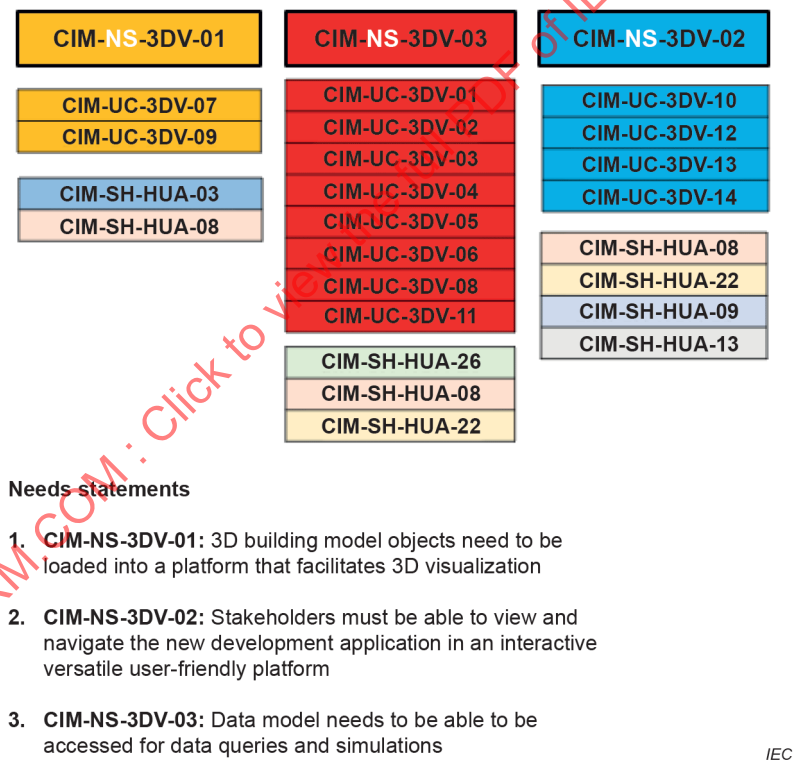


Figure 4 – Structure of use cases of applying city information modelling in 3D visualization of development application

The fourteen use cases show seven distinct scope and objectives for the use cases including to assess new developments against resiliency measures; to assess new developments against key community assets; to review and anticipate the changes in my communities built environment; to support community engagement in built environment and infrastructure developments; to manage the land use and planning instruments in a data driven way; to support community engagement in built environment and infrastructure developments; to provide spatial and temporal pending and planned infrastructure developments in a digital environment; and to create a data supply chain for better assessment and approval metrics and validations (Figure 6).

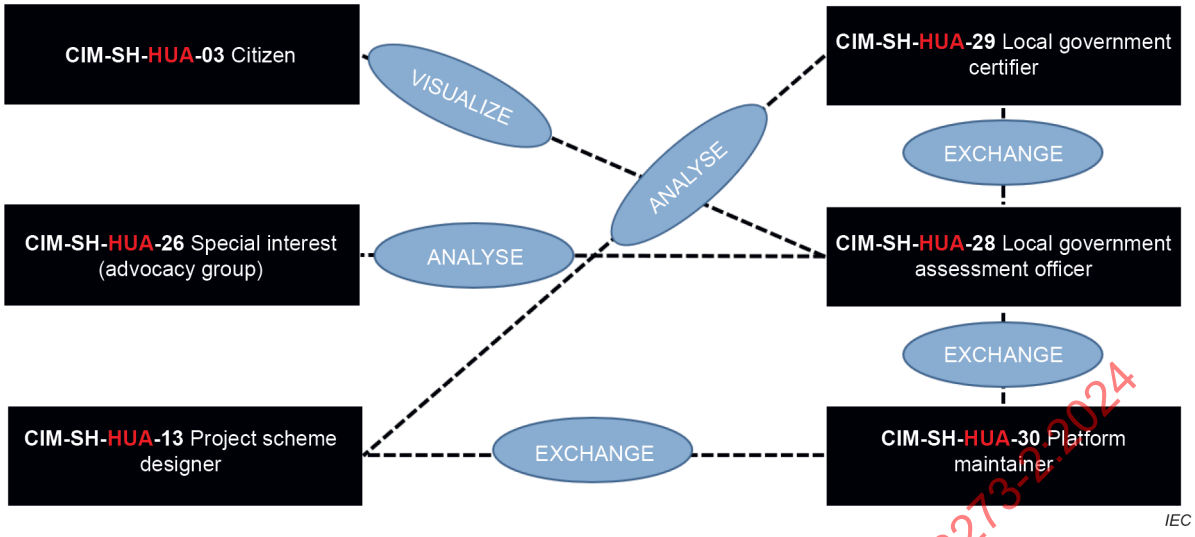


Figure 5 – The relationships among different use cases of applying city information modelling in 3D visualization of development application

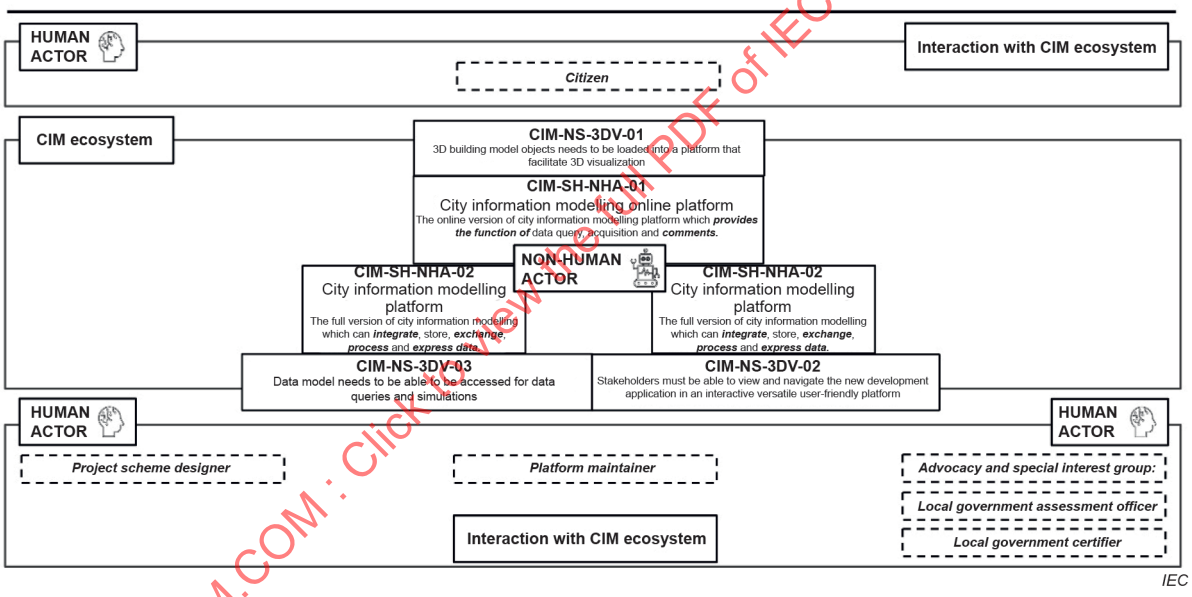


Figure 6 – Structure of use cases of applying city information modelling in 3D visualization of development application regarding needs statement

5.3.3 Requirements for the standards

- Regulation: Changes to how plans are drafted and how development applications are submitted to councils and the public for review (Figure 7).
- Standards: The implementation of standards should integrate different types of data into one CIM platform, such as digital plans, BIM and other geographical and infrastructure related data.
- Platform: Online shared platform for different stakeholders to review the planning and present their opinions and comments.
- Maintenance: The ability to load, maintain, update and retire the spatial objects.

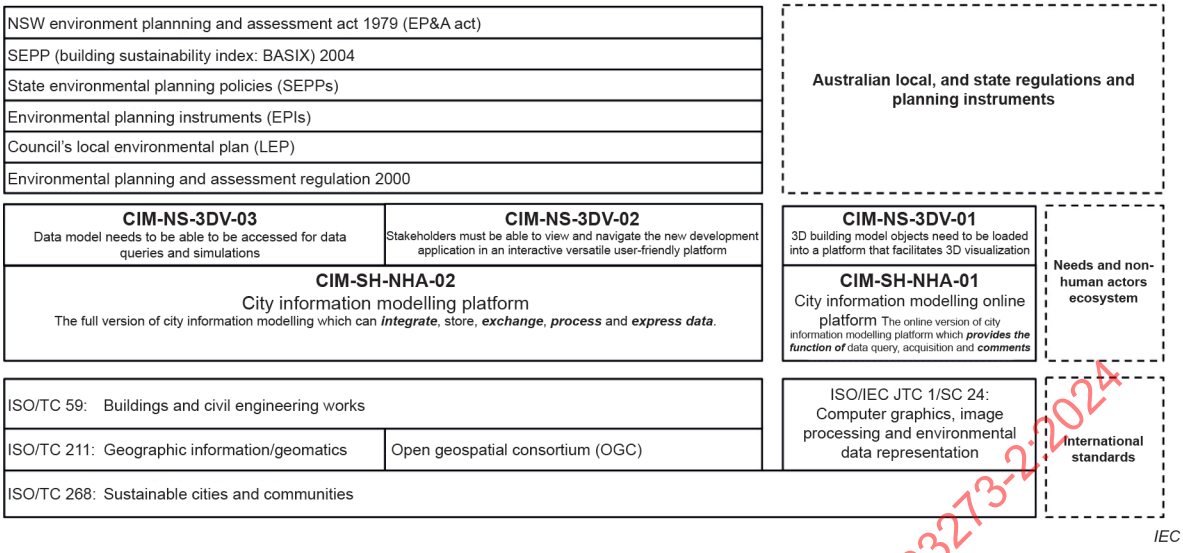


Figure 7 – Requirements for the standards of city information modelling in 3D visualization of development application

5.3.4 Related documents

Validation rules within the system can be based on local, state and national regulations on developments. These planning instruments can be converted to spatial and non-spatial rules within the system to support the validation and assessment of new development plans with computational and automated reasoning. Examples of these planning instruments and regulations are listed below:

- Council's local environmental plan (LEP)
- Environmental Planning and Assessment Regulation 2000
- Environmental Planning Instruments (EPIs)
- State Environmental Planning Policies (SEPPs)
- Local Environmental Plans (LEPs)
- SEPP (Building Sustainability Index: BASIX) 2004
- Development consent and construction certificate
- State Environmental Planning Policy (Exempt and Complying Development Codes) 2008 (Codes SEPP)
- NSW Environmental Planning and Assessment Act 1979 (EP&A Act).
- Local Environmental Plans (LEPs)
- Maximum building height

5.4 Construction approval management

5.4.1 Use cases

See Table 3.

Table 3 – The use cases of applying CIM in construction approval management

ID of UC	Name of UC	Scope/objective	Narrative	Actors (human and non-human)
CIM-UC-CAM-01	Government approves projects	Ensure that the construction project plan submitted by real estate	The use case describes that the real estate developer uploads the construction project scheme (including	Construction project review manager, construction project approval managing

ID of UC	Name of UC	Scope/objective	Narrative	Actors (human and non-human)
		developer is legal and compliant	graphics and text) to the platform. The platform sets requirements in accordance with relevant specifications. The government reviews and approves the scheme according to the requirements to ensure that the scheme is legal and compliant.	authority, real estate developer, project scheme designer, CIM platform and software developer, CIM online platform, data storage facility
CIM-UC-CAM-02	Comparison of project schemes	When the project has multiple design schemes, choose a better one	This use case describes the government staff using the platform's different scheme comparison functions to select the best design scheme. In order to meet the requirements and self-interest, the developer can design a variety of construction project schemes. The platform should provide scheme comparison, analysis and other functions to assist the approvers to make scientific decisions and select the scheme that best meets the needs of urban development and citizens.	Construction project review manager, construction project approval managing authority, real estate developer, project scheme designer, CIM platform and software developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-CAM-03	Data integration	Review design plan indicators based on multi-sectoral and multi-industry data, scientifically evaluate the plan and make reasonable suggestions	This use case describes the aggregation of data from different departments and different industries to the CIM platform to provide a data basis for reviewers and scientifically and reasonably review the planning indicators of the construction project plan. The project plan involves multiple departments such as construction, planning, civil air defence, and greening. The plan approval needs to comprehensively consider the requirements of multiple parties. The comprehensive data allows the approvers to more accurately review the indicators and give reasonable suggestions.	Construction project review manager, construction project approval managing authority, real estate developer, project scheme designer, CIM platform and software developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-CAM-04	Provide project information based on authority	Evaluate people's purchasing power and coordinate appropriate project plans	This use case describes a real estate developer using the CIM platform to access multiple types of demographic data and use it for analysis. Developers need to obtain more information about the type and quantity of the population and their socio-economic conditions based on their permissions. It helps to calculate how much people can afford to buy a house, and the developer will make the best plan when bidding for a land use purchase plan.	Real estate developer, construction project approval managing authority, real estate developer, CIM platform and software developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-CAM-05	Communicate project schemes	The real estate developer passes the project requirements to the design professionals	This use case describes how the real estate developer communicates the requirements of the construction project with the scheme designer through the CIM platform. Designers need to design the project in accordance with the	Real estate developer, construction project approval managing authority, project scheme designer, CIM platform and software developer, CIM online platform,

ID of UC	Name of UC	Scope/objective	Narrative	Actors (human and non-human)
			requirements of the design professionals, including but not limited to the quantity, quality, style and architectural requirements of the project. Complete communication is very important to the project design and helps the developer to obtain a satisfactory solution.	data storage facility, CIM platform web server
CIM-UC-CAM-06	2D and 3D display of project schemes	It is more conducive to different stakeholders to understand the construction project plan	This use case describes how the real estate developer uses the CIM platform to make different stakeholders understand the construction project scheme in a multi-dimensional manner. The public possibly do not have the professional knowledge and skills to understand the project scheme. Real estate developers and design professionals should use multi-dimensional technology to explain project schemes in an easy-to-understand manner, and the CIM platform should provide simplified display functions.	Real estate developer, construction project approval managing authority, citizen, project scheme designer, CIM platform and software developer, CIM online platform, CIM platform web server
CIM-UC-CAM-07	Provide list and requirements of approval	Pass as many department approvals as possible to save approval time	This use case describes that the real estate developer obtains a list of documents required for approval by multiple departments on the CIM platform. Developers need to figure out what documents need to be submitted by each department, which helps to pass as many department approvals as possible and save time.	Real estate developer, construction project approval managing authority, project scheme designer, CIM platform and software developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-CAM-08	Real-time feedback of approval results	Be informed of the approval results in time and prepare for the next step	This use case describes that the developer knows the approval result in time through the CIM platform. After the government completes the project approval, the real estate developer needs to know the approval result in time. The platform should have real-time notification and timely communication functions.	Real estate developer, construction project approval managing authority, project scheme designer, CIM platform and software developer, CIM online platform, CIM platform web server
CIM-UC-CAM-09	Provide project design information	Design high-quality solutions for construction projects to satisfy design professionals	This use case describes that the design professionals obtain the relevant information of the construction project scheme through the platform, and design a high-quality scheme based on the information. Project scheme requirements and surrounding environmental conditions help designers quickly understand the situation and design high-quality plans.	Architectural designer, construction project approval managing authority, real estate developer, project scheme designer, CIM platform and software developer, CIM online platform, data storage facility, CIM platform web server

ID of UC	Name of UC	Scope/objective	Narrative	Actors (human and non-human)
CIM-UC-CAM-10	Pre-review check of project schemes	Pre-review and check the construction project scheme to be submitted, and get a preliminary understanding of whether the plan meets the requirements	This use case describes the pre-review and check function of the construction project scheme included in the CIM platform, and the project scheme designer checks the compliance of the plan index. After the designer finishes the plan, they need to compare the scheme with related requirements, find errors and optimize the plan, and finally submit a scheme that meets the requirements of real estate developers.	Architectural designer, construction project approval managing authority, real estate developer, project scheme designer, CIM platform and software developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-CAM-11	Hydropower pipeline collision detection	Find design loopholes, optimize the scheme to meet the requirements	This use case describes that project scheme designers use the platform's intelligent functions to carry out pipeline collision detection and optimize the design scheme. The CIM platform should be intelligent, providing a certain degree of automated detection and reminding functions to assist designers in the detection scheme.	Municipal designer, construction project approval managing authority, real estate developer, project scheme designer, CIM platform and software developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-CAM-12	Provide environmental information around the project	The surrounding environment and the project scheme are tested to ensure the pipeline connection	This use case describes the scheme designer using the CIM platform to obtain the data of civilian facilities around the project and use the data for detection and analysis. The piping around the project will affect the piping design of the project. The scheme designer needs to master the existing information and carry out inspections on the piping design of this project to check whether there will be a collision and optimize the project design scheme in time.	Municipal designer, construction project approval managing authority, real estate developer, project scheme designer, CIM platform and software developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-CAM-13	Provide data, systems, department functions	Fully understand the current situation and make a demand analysis to meet the requirements	This use case describes the software developers to obtain information and carry out demand analysis. Understanding the status quo (including department functions, existing data, systems, approval management processes) helps personnel quickly understand the various aspects of the software involved, identify possible problems and potential needs, and propose detailed, accurate needs analysis to ensure the software integrity of development.	Needs analyst for CIM platform and software, construction project approval managing authority, CIM platform and software developer, CIM online platform, data storage facility, CIM platform web server

ID of UC	Name of UC	Scope/objective	Narrative	Actors (human and non-human)
CIM-UC-CAM-14	Provide platform operation information	Find operational problems, do a good job in system operation and maintenance	This use case describes the operation and maintenance of the platform operation and maintenance party using the CIM platform operation information. Information such as environmental parameters, number of users, and user feedback can fully reflect the operating conditions of the system. Assist the operation and maintenance personnel to monitor the system in real time, find system problems in time, and improve the service ability of CIM platform project approval management.	CIM platform operator and maintainer, construction project approval managing authority, real estate developer, project scheme designer, CIM platform and software developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-CAM-15	Provide project review and approval data	Carry out big data research and analysis to facilitate government scientific decision-making	This use case describes the use of CIM platform project review, approval, and management data by scientific research institutions to conduct big data research and analysis. Comprehensive data collection and calculation are conducive to scientific research personnel to conduct analysis and research from multi-dimensional perspectives such as time and space, so that the government can better understand project classification, funding sources, project scale and other information, and make better scientific decisions.	Academic researcher, construction project approval managing authority, CIM platform and software developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-CAM-16	Resident citizens comment on the project scheme	Residents around the project understand the construction project and provide comments and suggestions for the scheme	This use case describes how citizens obtain construction project schemes from a residential perspective and provide comments. After the government has reviewed the construction project scheme, it will publish the scheme for public comments. The infrastructure such as schools, transportation, and commerce included in the project will enhance the living environment and housing value of surrounding residents. The residents will fully consider the infrastructure factors and make suggestions for the planning scheme.	Citizen, construction project approval managing authority, real estate developer, project scheme designer, CIM platform and software developer, CIM online platform, data storage facility, CIM platform web server

ID of UC	Name of UC	Scope/objective	Narrative	Actors (human and non-human)
CIM-UC-CAM-17	Working citizens comment on the project scheme	People working around the project understand the construction project and provide comments and suggestions for the scheme	This use case describes how citizens obtain construction project schemes from a work perspective and provide comments. After the government has reviewed the construction project scheme, it will publish the scheme for public comments. The transportation conditions, commercial and office buildings, and other infrastructure included in the project will optimize the commuting conditions and work opportunities of the surrounding staff. The citizens will fully consider the infrastructure factors and make suggestions for the planning scheme.	Citizen, construction project approval managing authority, real estate developer, project scheme designer, CIM platform and software developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-CAM-18	Investors evaluate the project scheme	Evaluate the project and make project investment decisions	This use case describes that investors obtain the proposed construction project scheme based on their authority, evaluate the value of the project, and decide whether to participate in investment. The construction, transportation and other infrastructure of the new project will greatly affect the value of the project. Individuals or business owners make an assessment based on the above information and decide whether to invest in the project in the future such as buying houses and commerce.	Business owner, construction project approval managing authority, real estate developer, project scheme designer, CIM platform and software developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-CAM-19	Carrying out design and drawing of urban road planning	Ensure the project can connect with the surrounding transportation facilities	This use case describes that transportation designer needs to obtain surrounding traffic facilities information, to carry out the design and drawing of the transportation scheme of the project. Traffic design should consider consistency and coordination, and the impact of the surrounding environment of the project.	Transportation designer, construction project approval managing authority, real estate developer, project scheme designer, CIM platform and software developer, CIM online platform, data storage facility
CIM-UC-CAM-20	Develop approval software	Develop and design based on user's functional requirements for the software	This use case describes the development and design of the development engineer based on the user's functional requirements for the software. Clear requirements help to understand software functions and provide goals for design and development.	CIM platform development engineer, construction project approval managing authority, real estate developer, project scheme designer, CIM platform and software developer, CIM online platform, data storage facility

ID of UC	Name of UC	Scope/objective	Narrative	Actors (human and non-human)
CIM-UC-CAM-21	Collect opinions from the citizens	Collect opinions from the citizens through the platform	This use case describes that public comment manager solicits citizens' opinions through the platform. Citizens put forward opinions on the construction project, the opinions can be exchanged on the platform, and collectors can quickly and accurately obtain opinions from citizens.	Construction project public comment manager, construction project approval managing authority, citizen, CIM platform and software developer, CIM platform
CIM-UC-CAM-22	Approve the construction project	Decide whether to approve the project	This use case describes that the construction project approval manager obtains the review results and citizens' opinions through the platform, as a basis, to decide whether to approve the project.	Construction project approval manager, construction project approval managing authority, CIM platform and software developer, CIM platform

5.4.2 Use case analysis

The purposes of applying city information modelling to construction approval management include: a) to provide intelligent assistance for approval management and improve the efficiency of government services; b) to realize the precise management of urban spaces and make the city more suitable for living and working, stimulating the development of urban transportation, environment, history, and culture; c) to help the public easily understand construction projects and improve public participation in the approval management of construction projects; d) to promote the linkage between relevant authorities for construction approval, and achieve the whole lifecycle of construction project management from land use approval, scheme design, construction, completion and final acceptance of construction projects.

The stakeholders of applying CIM to construction project approval management include: construction project approval managing authority (primary beneficiary, owner and builder), real estate developer (primary beneficiary and builder), project scheme designer (secondary beneficiary and designer), CIM platform and software developer (secondary beneficiary and maintainer), academic researcher (second beneficiary and users), citizen (tertiary beneficiary and users), business owners (tertiary beneficiary and users).

In the application area of construction project approval management, the CIM platform acts as a huge data processing centre, intelligent operation centre, and communication platform. The CIM platform can integrate construction project requirements, approval results and other documents into one platform, provide the government with intelligent approval, share multi-departmental and multi-industry data for developers and designers, and provide the public with easy-to-understand construction project schemes. The CIM platform is the bridge for efficient communication among different stakeholders. It can effectively collect public comments on the construction project scheme, thereby optimize the plan, and assist city managers with scientific decision-making in planning, construction, and management.

22 city information modelling use cases were collected in the application area of construction project approval management regarding the stakeholders of construction project approval authority (5 use cases), real estate developer (5 use cases), project scheme designer (5 use cases), CIM platform and software developer (3 use cases), academic researcher (1 use case), citizen (2 use cases), and business owner (1 use case) (Figure 8).

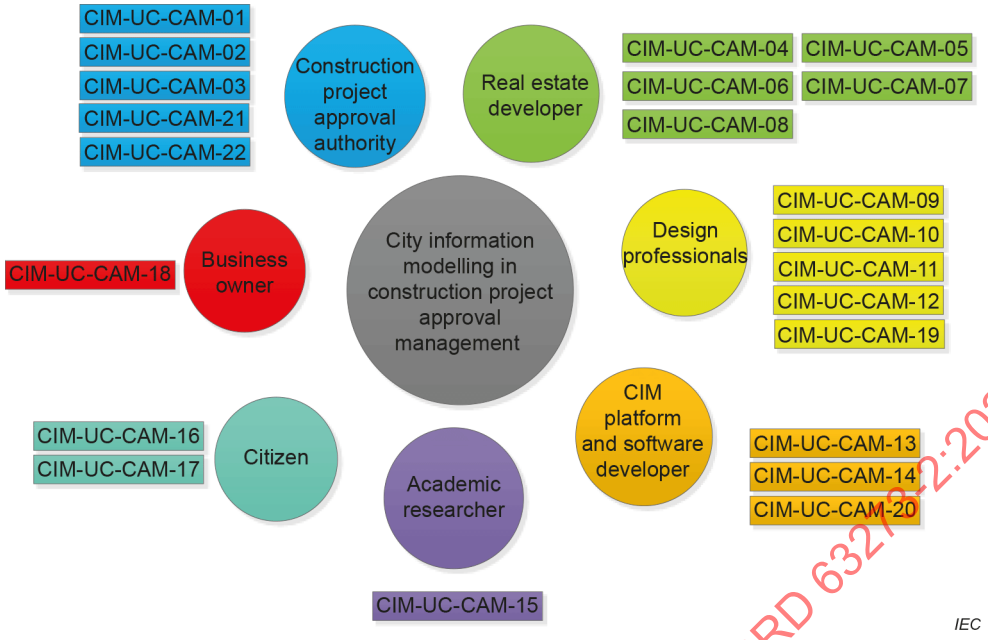


Figure 8 – Structure of use cases of applying city information modelling in construction project approval management regarding stakeholders

The user stories and use cases serve different needs of applying city information modelling to construction project approval management (Figure 9):

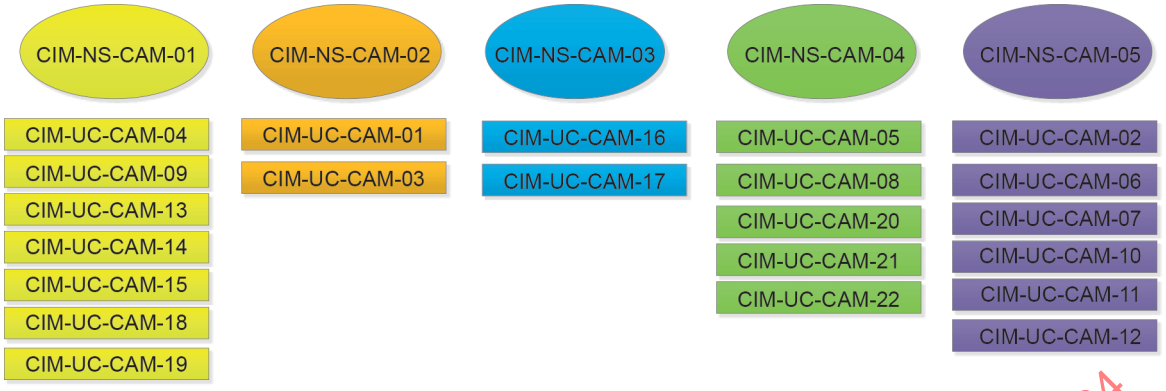
a) The platform has the capability of data classification management, and can identify the category of open data, shared data, and closed data (CIM-NS-CAM-01).

b) Documents such as construction project requirements, project scheme, application information, approval results, graphics, and text need to be gathered on the platform (CIM-NS-CAM-02).

c) Different stakeholders need to check, approve and comment on the proposed construction project scheme on a user-friendly platform (CIM-NS-CAM-03).

d) Different stakeholders can have effective communication regarding the project requirements, results of different approval stages, and acquire project approval results in real time (CIM-NS-CAM-04).

e) In response to the different scenarios of construction project approval management, users can carry out different intelligent operations according to the requirement and authorization, including but not limited to uploading, downloading, editing, and browsing data on the platform, two-dimensional and three-dimensional integrated display, multi-scheme comparison, and intelligent review (CIM-NS-CAM-05).



Needs statement:
CIM-NS-CAM-01: The platform has the capability of data classification management, and can identify the category of open data, shared data, and closed data;
CIM-NS-CAM-02: Documents such as construction project requirements, project scheme, application information, approval results, graphics, and text need to be gathered on the platform;
CIM-NS-CAM-03: Different stakeholders need to check, approve and comment on the proposed construction project scheme on a user-friendly platform;
CIM-NS-CAM-04: Different stakeholders can have effective communication regarding the project requirements, results of different approval stages, and acquire project approval results in real time;
CIM-NS-CAM-05: In response to the different scenarios of construction project approval management, users can carry out different intelligent operations according to the requirement and authorization, including but not limited to uploading, downloading, editing, and browsing data on the platform, two-dimensional and three-dimensional integrated display, multi-scheme comparison, and intelligent review.

IEC

Figure 9 – Structure of use cases of applying city information modelling in construction project approval management regarding needs statement

5.4.3 Requirements for the standards

a) Data management
- Terminology of applying CIM to construction project approval management
- Data classification catalogue of applying CIM to construction project approval management
- Data dictionary of applying CIM to construction project approval management

b) Data aggregation
- Apply CIM to construction project approval rules
- CIM data interface specification
- CIM data integration

c) Data exchange and sharing
- CIM platform data exchange and sharing specification

d) Data review and approval
- Construction application data standard of applying CIM to construction project approval management Part 1 Building
- Construction application data standard of applying CIM to construction project approval management – Part 2 Transportation
- Construction application data standard of applying CIM to construction project approval management – Part 3 Municipal
- Technical specification of applying CIM to construction project review and approval – Part 1 Building
- Technical specification of applying CIM to construction project review and approval – Part 2 Transportation
- Technical specification of applying CIM to construction project review and approval – Part 3 Municipal
- CIM database design specification

e) Platform intelligent operation
- CIM platform construction specification

5.4.4 Related documents

- ISO 37156:2020, Smart community infrastructures – Guidelines on data exchange and sharing for smart community infrastructures
- ISO 37166:2022, Smart community infrastructures – Urban data integration framework for smart city planning (SCP)
- Technical guidelines for city information modelling (CIM) basic platform (China) (Published by Ministry of Housing and Urban-Rural Development of the People's Republic of China in September 2020).

5.5 Project management during construction

5.5.1 Use cases

See Table 4.

Table 4 – The use cases of applying city information modelling in project management during construction

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-PMC-01	Submission of the design models to real estate developer/ construction regulator/ utility services provider for approval	To receive feedback, and check compliance	This use case describes that project scheme designers and/or construction practitioners should create and update their design documents, e.g. the BIM (building information modelling) model, to meet the requirements of the CIM platform for internal and external stakeholders to review.	Project scheme designers, construction practitioner, real estate developer, CIM platform, data storage facility, CIM platform web server, construction regulator, and utility services provider
CIM-UC-PMC-02	Checking the quality of CIM data before submission	To provide due diligence and ensure the CIM data is well coordinated and updated to reflect the construction-in-progress/as-built documentations	This use case describes the obligation of the construction practitioner in the creation, update, and verification process of CIM data. Project scheme designers typically submit "for construction" documentation to construction practitioners. The construction practitioners would have the obligation to check the design documentation and verify the accuracy of data before uploading data to the CIM platform.	Construction practitioner, project scheme designer, real estate developer, CIM platform, data storage facility, CIM platform web server, construction regulator, and utility services provider
CIM-UC-PMC-03	Understanding the progress of project and calculating the risk	To track the project progress and understand its risk	The real estate developer has the overall responsibility to own a project so that it can be delivered on time, with good quality and on budget. Besides regular inspections on site, a real estate developer should also refer to data constantly created and updated during the design/construction process. For example, 4D (3D + time) modelling helps the developers understand the project progress and identify any roadblocks the project team can be currently experiencing. The real estate developer can be tasked with submitting the final CIM dataset onto the platform.	Real estate developer, project scheme designer, construction practitioner, CIM platform, data storage facility, CIM platform web server, construction regulator, and utility services provider

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-PMC-04	Planning for existing services disruption and approving new connections	To plan for potential services disruption due to the new works and visualize new services connection proposal for approval	Without detailed information of where the disruptions are required, how enabling works will be performed on site and how new services will be laid or connected, utility services providers can struggle to understand the full intent of disruptions caused by new projects. Therefore, it is imperative that utility services providers be provided with the necessary details so that they can review and make decisions. The dataset should be maintained and updated frequently by utility services providers on the CIM platform for future project planning and delivery.	Utility services provider, project scheme designer, construction practitioner, real estate developer, CIM platform, data storage facility, CIM platform web server, and construction regulator
CIM-UC-PMC-05	Enforcement of regulatory oversight and provision of real-time supervision	To be supplied with compliance-essential project data and review the data	Construction regulators work with the project team for the purpose of enforcement and compliance checking. Regulators typically are overstretched with resource and, as a consequence, can randomly select a small portion of projects to audit or inspect once or twice during design or construction process. Data lodged by the project team onto the CIM platform would enable construction regulators to efficiently check and monitor project performance and progress, especially when practitioners with problematic track record are engaged on a project.	Construction regulator, project scheme designer, construction practitioner, real estate developer, CIM platform, data storage facility, CIM platform web server, and utility services provider
CIM-UC-PMC-06	Understanding the intent of new developments	To access development information and be informed of the intent	Citizens who live near the construction project need to be informed of the projects happening around them. CIM platform would provide a centralized place for citizens to access the data and understand the intent of new development around them.	Citizen who lives near the construction project, CIM platform, data storage facility, CIM platform web server, and construction project approval manager
CIM-UC-PMC-07	Using data to approve development applications	To visualize new development, by understanding the scope and making decisions on applications	By accessing data on the CIM platform, construction project approval manager would be able to compare cases and make better informed decisions	Construction project approval manager, project scheme designer, construction practitioner, construction developer, CIM platform, data storage facility, CIM platform web server, construction regulator, asset manager and utility services provider
CIM-UC-PMC-08	Using data to plan for future urban development	To visualize the current urban development, and plan for future developments	By accessing data on the CIM platform and being capable of making data driven decisions, urban planners would be able to visualize development of urban areas and hence plan for future expansion in greater confidence	Urban planner, project scheme designer, construction practitioner, construction developer, CIM online platform, data storage facility, CIM platform web server, construction regulator, asset manager and utility services provider

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-PMC-09	Turning project CIM data into asset management tools	To further utilize data created during the project development in operations and maintenance activities	Asset managers are becoming more and more data savvy. A real asset digital twin with live data collection can soon become the new norm for asset managers. Rather than start everything from scratch, asset managers can utilize the data created via the CIM process by the project team during design and construction. They can then refine the details to reflect assets accurately through asset lifecycle.	Asset manager, project scheme designer, construction practitioner, construction developer, CIM platform, data storage facility, CIM platform web server, construction regulator, urban planner, construction project approval manager, and utility services provider

5.5.2 Use case analysis

The use cases demonstrate that CIM serves common purposes for stakeholders in the construction industry. The purposes are: a) enabling city-level information visualization; b) achieving transparency and accuracy in making data-driven decisions; c) acting as a vehicle for better collaboration; d) delivering physical and digital building products with better quality, on time and on budget.

During the design and construction process, construction projects typically generate large amount of data. In recent years, the penetration and adoption of modelling technology have digitalized building projects and paved the way for the next stage of data collection, analysis, sharing and overall consumption. However, for most projects these days, modelling is used mainly for visualization purpose and data remains largely not utilized for further analysis. Therefore, a city level platform can potentially break the silos between different construction projects and enable large scale data analysis and comparison activities for all stakeholders. This will promote a culture of making data driven decisions, facilitate further collaborations, and eventually deliver better quality products.

Nine user cases have been collected under this application scenario. For project scheme designer and construction practitioners, their roles appear to be more internally facing and their obligations are critical to supply accurate data to other stakeholders, in particular, the real estate developers.

Real estate developers act as the interface between the project team and external stakeholders. They ensure the data are created in a prescribed format and reflect the actual installation status of the projects. Once they are confident, they upload the data to CIM platform and provide updated building models accordingly.

Then, external stakeholders access data and consume them for their own purposes. For construction regulators, construction project approval manager, utility services providers and urban planners, they review the data for enforcement, compliance and planning purposes. For citizens, they access the data for visualization and general information. Lastly for asset managers, they use the data for digital twinning and own the responsibility to update the data after assets have been completed and handed over.

5.5.3 Requirements for the standards

According to the use cases, the following standards can be developed to support the data exchange and utilization on the city level for construction projects.

- Standards on the city level data sharing framework
- Standard reference documents to guide the implementation of each use case under this application scenario
- Standards that prescribe the format, type, and level of details of the CIM data generated from construction projects

Such standards have overlaps with standards developed for other scenarios under CIM and therefore can be developed as separate parts under the same series of CIM standards instead of stand-alone documents.

5.5.4 Related documents

None.

5.6 Real estate registration management

5.6.1 Use cases

See Table 5.

Table 5 – The use cases of applying city information modelling in real estate registration management

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-RER-01	Formulate real estate registration apply requirements	Formulate specific handling guidelines and regulations to ensure that the documents provided by real estate owners meet the relevant management technical requirements	This use case describes that the real estate registration requirement specifier formulates specific handling guidelines and regulations in order to better apply for registration of real estate owner, so that the documents provided by real estate owners meet the relevant management technical requirements and conduct registration applications.	Real estate registration requirement specifier, real estate registration authority, real estate owner, CIM platform and software developer, CIM platform, CIM online platform, CIM platform web server, data storage facility
CIM-UC-RER-02	Multi-department, multi-industry data sharing	According to the data provided by the real estate relevant business department, accurately review the payment of real estate rights holders	This use case describes the aggregation of data from different departments and different industries on the CIM platform, providing a data basis for approval officer, and scientifically reviewing the payment of real estate rights holders. The fees to be paid by real estate rights holders include deed taxes, maintenance funds, loans and other expenses, involving taxation, banking and others	Real estate registration authority, real estate registration relevant business authority, real estate owner, CIM platform, CIM online platform, CIM platform web server, data storage facility

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-RER-03	First registration of construction land use rights	Review the relevant documents for real estate registration applications and make more scientific and rational judgments on the situation of construction land	This use case describes the real estate registration approval officer in accordance with the regulations and standards, to review the real estate registration application form, assignment contract, survey report and map, land confirmation and other documents, complete the registration procedures, and issue certificates.	Real estate registration approval officer, real estate registration authority, real estate owner, CIM platform, CIM online platform, CIM platform web server, data storage facility
CIM-UC-RER-04	Provide real estate registration information for banks	Based on the real estate registration information provided, evaluate the value of real estate and decide the amount of loan	The use case describes that banking staff can obtain real estate registration information through CIM platform, such as property right information, owner information, etc., to evaluate the value of real estate, so as to determine the lending amount.	Real estate registration authority, real estate registration relevant business authority, real estate owner, CIM platform, CIM online platform, CIM platform web server
CIM-UC-RER-05	Provide real estate registration information for tax department	Based on the real estate registration information provided, the tax amount can be calculated quickly	The use case describes that tax staff can obtain real estate tax information through CIM platform, quickly calculate the amount of tax, and improve the efficiency of government services.	Real estate registration authority, Real estate registration relevant business authority, real estate owner, CIM platform, CIM online platform, CIM platform web server
CIM-UC-RER-06	Provide real estate registration information for the court	Based on the real estate registration information provided, the seal up can be carried out quickly and accurately	The use case describes that the court staff can obtain the real estate registration information through CIM platform and implement the sealing up quickly and accurately.	Real estate registration authority, Real estate registration relevant business authority, real estate owner, CIM platform, CIM online platform, CIM platform web server
CIM-UC-RER-07	Viewing the 3D model and querying properties of my own real estate	To achieve better understanding of real estate structure and prepare for decoration	This use case describes how a real estate owner who is going to make decorations achieves better understanding of real estate structure by viewing the 3D model and querying properties on CIM platform. The owner needs spatial and geometric information with attributes of real estate provided by 3D visualization to make decisions when and how to make plans for decorations appropriately and efficiently.	Real estate registration authority, real estate owner, CIM platform and software developer, CIM platform, CIM online platform, CIM platform web server, data storage facility
CIM-UC-RER-08	Inquiring specific document requirements of real estate registration	To know specific document requirements and to avoid disapproval caused by not meeting registration document requirements	This use case describes what a real estate owner should prepare for the real estate registration. The owner can conveniently acquire specific document requirements and submit adequate materials during registration process online. Relevant certificates, identifications, photos required can be elaborated distinctly to applicant, which can reduce the appearance of disapproval caused by lack of material and requirements	Real estate registration authority, real estate owner, CIM platform and software developer, CIM platform, CIM online platform, CIM platform web server, data storage facility

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-RER-09	Inquiring the address and process of real estate registration	To achieving comprehensive understanding process and address of real estate registration so as to complete the registration at one time and save time	This use case describes how a real estate owner who is going to apply for real estate registration acquires address and process of registration. With the introduction formed by normalized rules of real estate registration from CIM platform, applicant can gain clearly and comprehensively a guide of sequential steps during the registration as well as the location, which is time-saving and contributes to the success rate of registration.	Real estate registration authority, real estate owner, CIM platform and software developer, CIM platform, CIM online platform, CIM platform web server, data storage facility
CIM-UC-RER-10	Obtaining the legal digital version real estate certificate	To obtain the legal digital version real estate certificate for preservation	This use case describes a new condition that a real estate owner can obtain the certificate of real estate online. Different than before, a digital certificate can be issued after confirmation online. After approval, it can be simply downloaded through specified zone on CIM platform. The digital version seems to be more convenient for use and preservation regardless of unexpected breakage	Real estate registration authority, real estate owner, CIM platform and software developer, CIM platform, CIM online platform, CIM platform web server, data storage facility
CIM-UC-RER-11	Develop CIM software and software	Develop and design based on platform standards	This use case describes the development and design of the CIM platform by CIM platform development engineer in accordance with standard specifications. Understanding the relevant data and data standards helps personnel understand the functions required by the platform and ensure the integrity of software development.	Real estate registration authority, real estate registration relevant business authority, CIM platform and software developer, CIM platform, CIM online platform, CIM platform web server, data storage facility
CIM-UC-RER-12	Operate and maintain CIM platform and software	Find operational problems, do a good job in system operation and maintenance	This use case describes the CIM platform operator's and maintainer's use of the CIM platform to operate information management and maintenance. Information such as environmental parameters, number of users, and user feedback can fully reflect the operation of the system. Assist operation and maintenance personnel to monitor the system in real time, discover system problems in time, and improve the service capabilities of the CIM platform for real estate registration management.	Real estate registration authority, real estate registration relevant business authority, CIM platform and software developer, CIM platform, CIM online platform, CIM platform web server, data storage facility
CIM-UC-RER-13	Real estate registration and management big data research	Conduct big data research and analysis to facilitate the government's scientific decision-making	This use case describes research institutions use of real estate registration management data from CIM platform, to conduct big data research and analysis. Comprehensive data collection and calculation are conducive to scientific research personnel to carry out analysis and research from multi-dimensional perspectives such as time and space. This is so the government can better understand the classification, sources of funds, project scale and other information, and make better scientific decision-making.	Real estate registration authority, real estate registration relevant business authority, real estate owner, CIM platform and software developer, academic researcher, CIM platform, CIM online platform, CIM platform web server
CIM-UC-RER-14	Platform and software needs analysis	Fully understand the current situation and make a demand analysis to meet the requirements	This use case describes the demand analyst to obtain information and carry out demand analysis. Understanding the status quo (including department functions, existing data, systems, registration management processes) helps personnel quickly understand the various aspects of the software involved, identify possible problems and potential needs, and propose detailed, accurate needs analysis to ensure the software integrity of development.	Real estate registration authority, real estate registration relevant business authority, CIM platform and software developer, CIM platform, CIM online platform, CIM platform web server, data storage facility

5.6.2 Use case analysis

The application of city information modelling to real estate registration management aims to: a) integrate the real estate, its three-dimensional model data, ownership confirmation and registration in one platform; b) improve the registration and management of mixed-use real estate, which includes residential or commercial real estate above the ground, underground garages and underground shopping malls; c) conduct spatial analysis, and generate thematic maps of real estate information; d) realize multi-dimensional visualization, and improve the public's understanding of the real estate from a multi-dimensional perspective; e) advance the data exchange and connection among the real estate management authorities, financial institutions, court, civil affairs and other relevant departments to increase the efficiency of registration management; f) promote the connection among all the departments involved in real estate registration, and realize the effective connection among real estate registration and land use approval, scheme design, construction, completion and final acceptance.

The stakeholders of applying CIM to real estate registration management include real estate registration authority (primary beneficiary, owner and builder), real estate registration relevant business authority (secondary beneficiary, user), real estate owner (primary beneficiary, builder), CIM platform and software developer (secondary beneficiary, maintainer), academic researcher (second beneficiary, user).

In the application scenario of real estate registration management, the CIM platform acts as a huge centre for data processing, intelligent operation, communication, and management. The real estate registration authority and related business departments integrate many different types of data into the CIM platform, such as apply requirements, documents, registration basis and other documents. The CIM platform can provide intelligent assistance for data sharing and information exchange among the authority, real estate owners, CIM platform developers and academic researchers. The CIM platform builds a bridge for an efficient and effective communication among different stakeholders.

Fourteen city information modelling use cases were collected in the application area of real estate registration management regarding the stakeholders of real estate registration authority (3 use cases), real estate registration relevant business authority (3 use cases), real estate owner (4 use cases), CIM platform and software developer (3 use cases), academic researcher (1 use case) (Figure 10).

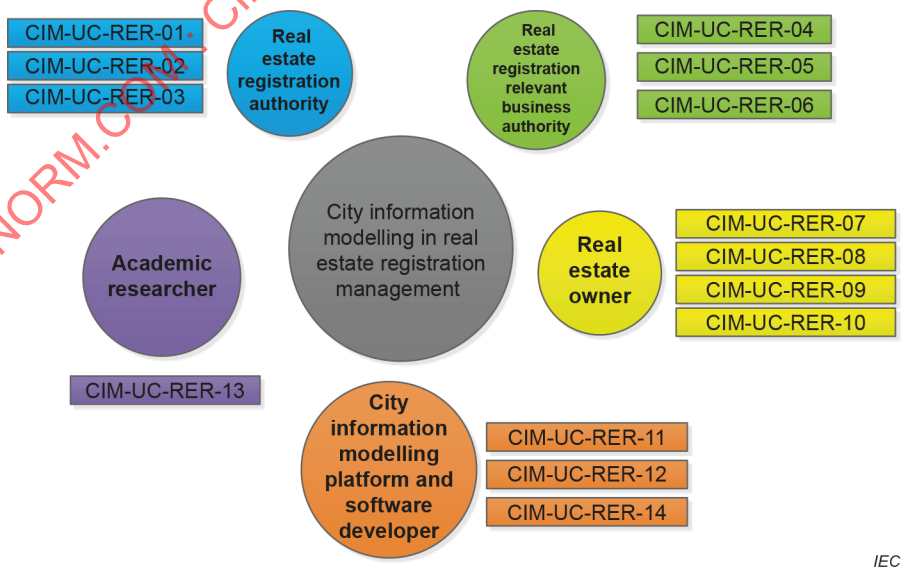


Figure 10 – Structure of use cases of applying city information modelling in real estate registration management regarding stakeholders

The user stories and use cases serve different needs of applying city information modelling to real estate registration management (Figure 11):

a) It has the ability to manage real estate registration data, such as apply requirements, apply documents, basic documents, graphics, texts, and can categorize them into open data, shared data, and closed data (CIM-NS-RER-01).

b) The platform has the ability to review, approve and evaluate real estate registration cases (CIM-NS-RER-02).

c) The platform can effectively transmit and communicate the requirements, issue application results, and provide users with real-time access to approval results (CIM-NS-RER-03).

d) The platform can carry out different intelligent operations, including uploading, downloading, editing, and browsing data on the platform, 2D and 3D real estate display, electronic licence, etc. (CIM-NS-RER-04).

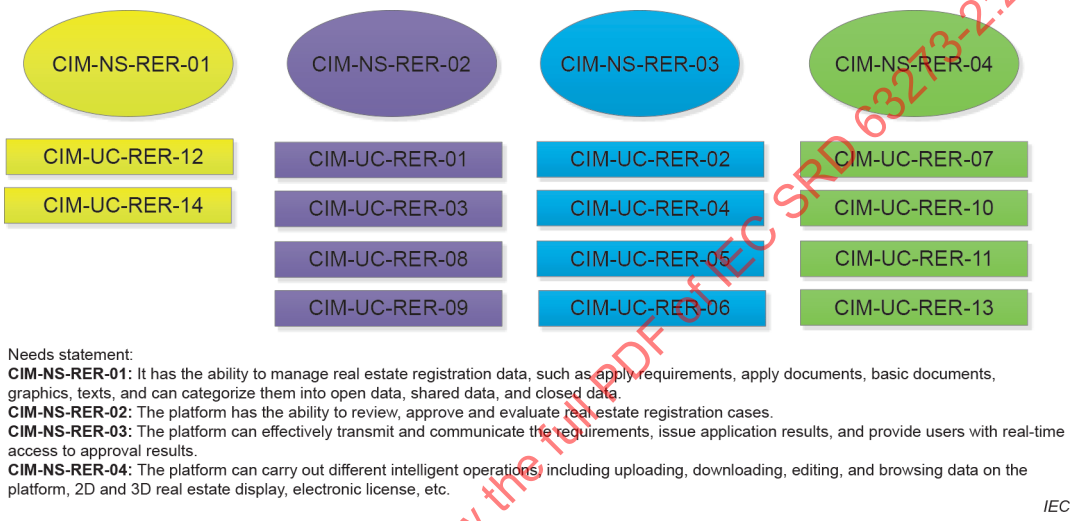


Figure 11 – Structure of use case of applying city information modelling in real estate registration management regarding needs statement

5.6.3 Requirements for the standards

a) Data management and aggregation
   - CIM terminology
   - CIM data classification catalogue
   - CIM data dictionary
   - CIM data security
   - CIM database design specification
   - CIM data integration

b) Data review and approval
   - Rules of applying CIM to real estate registration management
   - Technical specification of applying CIM to real estate registration review and approval

c) Data exchange and sharing
   - CIM platform data exchange and sharing specification

d) Platform intelligent operation
   - CIM data interface specification
   - CIM platform construction specification

5.6.4 Related documents

- ISO 37156:2020, Smart community infrastructures – Guidelines on data exchange and sharing for smart community infrastructures
- ISO 37166:2022, Smart community infrastructures – Urban data integration framework for smart city planning (SCP)
- Technical guidelines for city information modelling (CIM) basic platform (China). (Published by Ministry of Housing and Urban-Rural Development of the People's Republic of China in September 2020)

5.7 City management using city brain

5.7.1 Use cases

See Table 6.

Table 6 – The use cases of applying city information modelling in city management using city brain

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-CBR-01	Analysing the quality of economic-development and taking correct measures to promote economic development	To obtain the data on behalf of economic-development and monitor real-time economic operation state.	This use case describes how economy manager takes measures to promote the economic development of the city. Economy is one of the most important aspects of the city management. The economy manager needs to know about the predominant industries and their development circumstance. Then the economy manager finds out the influence factors of economic development and takes measures to promote economic development.	Economy manager, academic researcher, data storage facility, CIM platform, CIM online platform,
CIM-UC-CBR-02	Carrying out the market supervision	To know about market operation environment and maintain good market order and fair market competition	This use case describes how the market manager maintains good market order and fair market competition. Good market order and fair market competition are an important guarantee for economic development. The market manager needs to know about market operation environment.	Market manager, academic researcher, data storage facility, CIM platform, CIM online platform, CIM platform web server
CIM-UC-CBR-03	Carrying out population management	To promote the coordinated development of population, resources, economy and environment	This use case describes how the population manager monitors population mobility and population structure for each street. The population size, population mobility and population quality play an important role in social development and stability. The population manager needs to make population coordinated with environment, resources, economy.	Population manager, academic researcher, data storage facility, CIM platform, CIM online platform, CIM platform web server
CIM-UC-CBR-04	Maintaining urban safety	To monitor the sources of urban security risks, find the hidden danger and reduce the incidence and harm of safety accidents.	This use case describes how the city safety manager finds the hidden danger. Urban security is related to the life and property security of the citizens. The city safety manager needs to find the hidden danger and minimize the incidence and harm of safety accidents.	City safety manager, data storage facility, CIM platform, CIM online platform, CIM platform web server

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-CBR-05	Dealing with emergency events	To take immediate action and minimize the damage and loss of emergency event	This use case describes how the emergency manager deals with emergency events. Different departments need to be collaborative to minimize the damage and loss of emergency event.	Disaster and emergency manager, data storage facility, CIM platform, CIM online platform, CIM platform web server, sensing equipment
CIM-UC-CBR-06	Making plans for public resource construction and providing public service	To know the distribution of education resources, land resources, medical resources and tourism resources, the employment situation	This use case describes how the public resource manager balances development of public resources and solves the problem of unemployment. The public resource manager has the responsibility to let the public enjoy equal public resources and provide more employment.	Public resource manager, data storage facility, CIM platform, CIM online platform, CIM platform web server, sensing equipment
CIM-UC-CBR-07	Governing environmental pollution	To monitor the real-time quality of air, and water, ecological garden and find out the cause and the location of the pollution	This use case describes how the environment manager deals with environmental pollution. Smart city is green and sustainable. The environment manager needs to protect the environment while developing the economy.	Environment manager, data storage facility, CIM platform, CIM online platform, CIM platform web server, sensing equipment
CIM-UC-CBR-08	Solving the hot and difficult problems concerned by the public	To find out the kinds and distributions of the public appeals and solve the problems in a timely manner	This use case describes how the public appeal manager obtains the effects of city management from the public, finds the existing problems in city management, takes improved measure, and enhances the public's sense of happiness and satisfaction. The public appeals reflect the effect of city management to a large extent. In order to improve city management, the public appeal manager needs to obtain the top five of the public appeals, find out the temporal and spatial distribution of the appeals, check the government's processing efficiency. Then public appeal manager finds the solutions to the problems and strengthens the management of regions with more appeals.	Public appeal manager, data storage facility, CIM platform, CIM online platform, CIM platform web server, sensing equipment
CIM-UC-CBR-09	Conducting an investment in industry	To have a better understanding of the current situation and problems of the industry and evaluate whether it is worth investing	This use case describes how the financial suppliers/investors evaluate whether one industry is worth investment. The purpose of financial suppliers/investors is to get a return from the industry they invest in. The financial suppliers/investors need to know about the current situation and problems of the industry before investing in the industry.	Financial supplier/investor, data storage facility, CIM platform, CIM online platform, CIM platform web server, sensing equipment
CIM-UC-CBR-10	Doing research on city management	To analyse the city operation from multiple aspects and dimensions, find the current problems and the corresponding solutions	This use case describes how the academia and research institutions do research on city management. Academia and research institutions also play an important part in city management. They need to make deeper innovation, propose improved method and cultivate talents for city management.	Academic researcher, data storage facility, CIM platform, CIM online platform, CIM platform web server, sensing equipment

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-CBR-11	Selecting one registered address for one company and making decisions on the business scope	To obtain market, trade, industry and business environment of the city for decision making to register one company	This use case describes how the CEO obtains market, trade, industry and business environment of the city, uses them for analysis and decision making to register one company. The registering address and business scope of the company plays an important part in the development of company. More innovative and dynamic industrial environment promotes the rapid development of business.	CEO, data storage facility, CIM platform, CIM online platform, CIM platform web server, sensing equipment
CIM-UC-CBR-12	Selecting the community surrounded by good educational and medical resources	To know the distribution of educational and medical resources and select one community surrounded by good educational and medical resources	This use case describes how the citizen selects the community when they buy one house. The householder needs to consider the surrounding resources, especially the schools, hospitals, before they select the community for the house	Citizen, data storage facility, CIM platform, CIM online platform, CIM platform web server, sensing equipment
CIM-UC-CBR-13	Making optimal travelling schedule for visiting different scenic spots to bypass periods of high visitor flows during the holidays	To know visitor flows at the scenic spots and make optimal travelling schedule for visiting different scenic spots during the holidays	This use case describes how the citizen makes optimal travelling schedule for visiting different scenic spots during their holidays. The traveller needs to consider the visitor flows at the scenic spots during the holidays before they travel. Then they can make optimal travelling schedule for visiting different scenic spots to bypass periods of high visitor flows and enjoy the scenery.	Citizen, data storage facility, CIM platform, CIM online platform, CIM platform web server, sensing equipment

5.7.2 Use case analysis

The application of city information modelling (CIM) to the city brain aims to: a) establish three-dimensional city model; b) integrate different types of urban information; c) monitor, simulate and display city operation in real-time, visually and intuitively.

The stakeholders of applying CIM to the city management include local government and administrations (primary beneficiary, designer, owner, maintainer and user), financial suppliers/investors, developers (secondary beneficiary, user), academia and research institutions (secondary beneficiary), citizens and business owners (tertiary beneficiary). The local government and administrations play a critically important role to connect all the other stakeholders.

CIM serves as a giant data hub, central processing unit and 3D visualization platform in city management. Firstly, the CIM can assist in creating three-dimensional city model based on modern surveying and mapping, GIS, BIM, 3D modelling and other technologies. Secondly, CIM integrates dynamic spatiotemporal data and builds a dynamic digital city. Thirdly, CIM displays the real-time city operation state of the whole city, or a certain field analysed by the city brain visually and intuitively.

Thirteen city information modelling use cases were collected in the application area of city management regarding the stakeholders of the local government and administrations (8 use cases), financial suppliers/investors (1 use case), academia and research institutions (1 use case), citizens (2 use cases) and business owner (1 use case) (Figure 12).

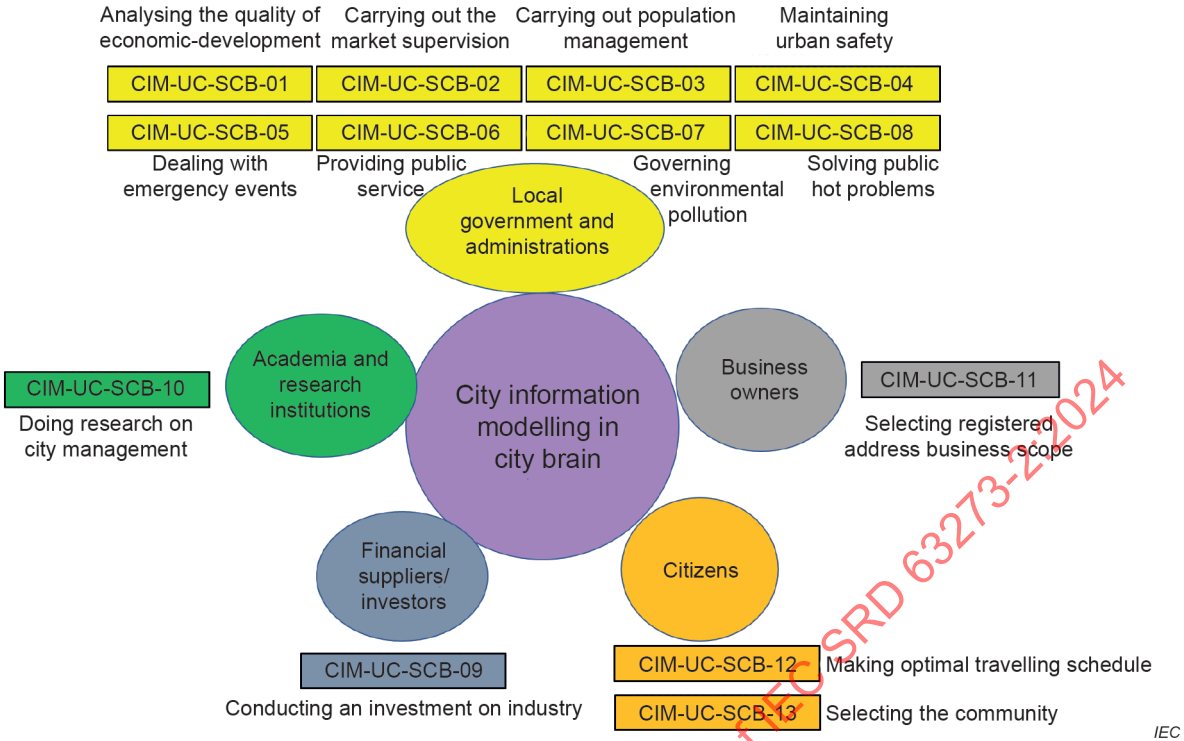


Figure 12 – Structure of use cases of applying city information modelling in city brain regarding stakeholders

The user stories and use cases serve different needs of applying city information modelling to city brain (Figure 13): a) the urban space needs to be displayed in three-dimensional format (CIM-NS-CBR-01, 1 use case); b) different types of urban information need to be stored and accessed in one platform (CIM-NS-CBR-02, 9 use cases); c) city operation needs to be monitored in real time(CIM-NS-CBR-03, 2 use cases); d) city operation needs to be simulated and analysed in real time to issue risk warning effectively (CIM-NS-CBR-04, 1 use case).

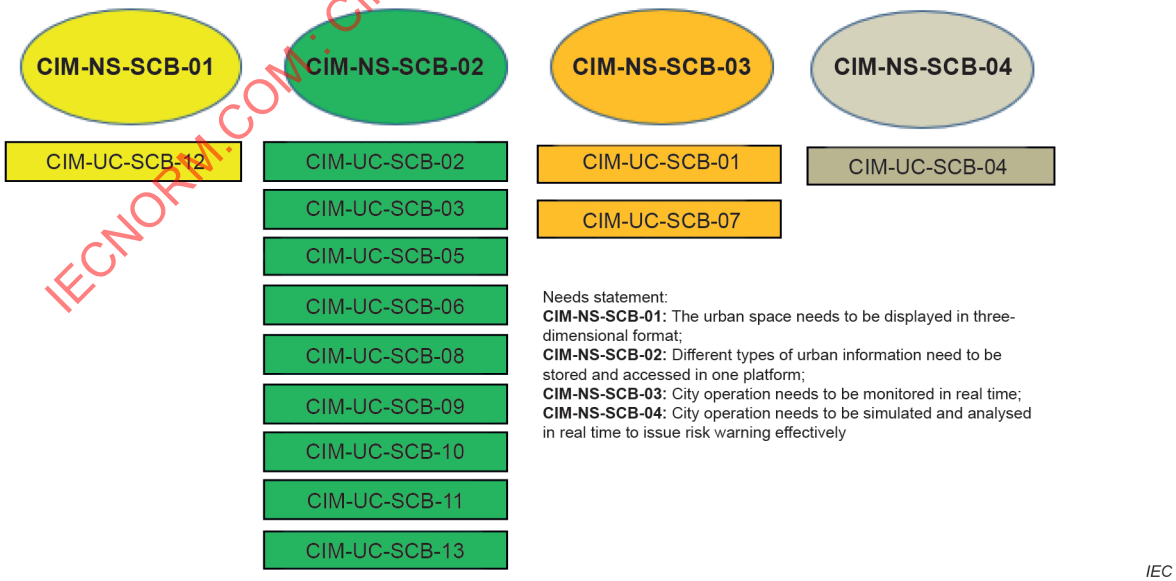


Figure 13 – Structure of use cases of applying city information modelling in city brain regarding needs statement

There are seven kinds of actors (Figure 14) participating in the use cases of applying city information modelling in city brain. ICT service providers, evaluation indicator system and data lake participate in every use case: data lake is the infrastructure of upper application; evaluation indicator system is to calculate the development level of the indexes in each case; and ICT service providers are the constructors of data lake. Other actors participate in the use cases they need.

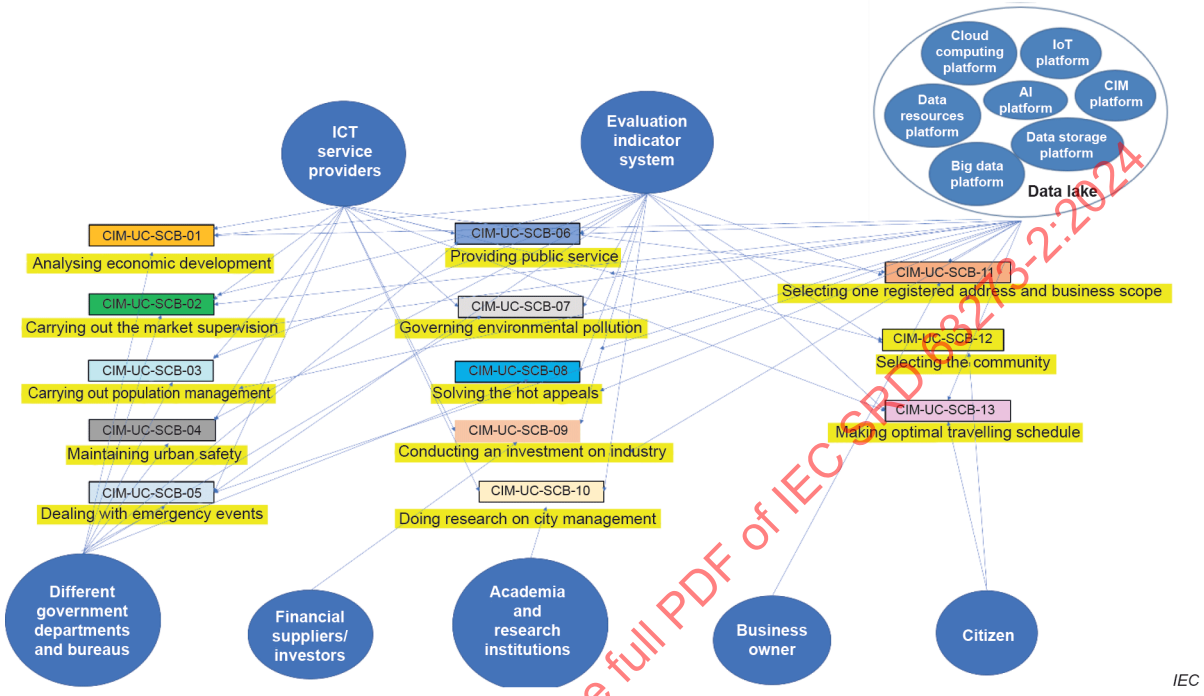


Figure 14 – Structure of use case of applying city information modelling in city brain regarding actors

5.7.3 Requirements for the standards

- Basic data specification of city information modelling platform
- Evaluation model and general evaluation indicator system for urban governance level

5.7.4 Related documents

Relevant standards of applying city information modelling to city brain:

- ISO 37166:2022, Smart community infrastructures – Urban data integration framework for smart city planning (SCP)
- Technical guidelines for city information modelling (CIM) basic platform (China)
- Spatiotemporal infrastructure for smart city – Basic specifications (China)
- Spatiotemporal infrastructure for smart city – Evaluation indicator system (China)
- Technical specification for cloud platform of geographic spatiotemporal information (China)
- Operation and maintenance specifications for cloud platform of geographic spatiotemporal information (China)
- Technical specification for big data of geographic spatiotemporal information (China)
- Evaluation indicator system for cloud platform of geographic spatiotemporal information (China)

5.8 Heritage preservation and revitalization

5.8.1 Use cases

See Table 7.

Table 7 – The use cases of applying city information modelling in heritage preservation and revitalization

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-HPR-01	A large amount of data exchange	To exchange a large amount of data in multiple formats	This use case describes how different government departments can upload different types of data, and urban planners can access these data by using CIM platform. The heritage preservation and revitalization planning needs to collect data from multiple different departments, such as water, transport, civil engineering, health, travel, etc. Different government departments can upload their data according to the requirements in one CIM platform. The urban planner can access the data with permission.	Urban planner, economy manager, market manager, population manager, CIM platform developer, city safety manager, disaster and emergency manager, public resource manager, environment manager, CIM platform and software developer, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-HPR-02	User-friendly modelling platform	To provide a user-friendly and platform for data integration and simulation	This use case describes the level of operation in the CIM platform. Different types of users will use the CIM platform. They may not have professional skills, such as programming, modelling, and scenario simulation. The CIM platform provides a user-friendly platform without any high-level skills operation.	Urban planner, CIM platform and software developer, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-HPR-03	Comment function	To provide a comment function	This case describes the comment function of CIM platform. Urban planners should communicate with different stakeholders, which include the general public, organizations and other government departments. Urban planners need to present the planning and collect the comments of different types of stakeholders. CIM online platform provides a function of checking the comments and presents their comments.	Urban planner, economy manager, market manager, population manager, CIM platform developer, city safety manager, disaster and emergency manager, public resource manager, environment manager, CIM platform and software developer, citizen, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-HPR-04	Visualization analysis	To provide a function of visualization analysis for setting the scope of heritage planning	This case describes how urban planners use CIM to set the scope of heritage revitalization and the scope of buffer. Different situations need to be analysed for setting the scope, which include local economic development, distribution of heritage, transportation, etc. Urban planners should set the scope of heritage preservation and revitalization according to the situation and set the scope of buffer for adjustment in the future, The CIM provides a function of visualization analysis to make it.	Urban planner, CIM platform and software developer, CIM platform, CIM online platform, data storage facility, CIM platform web server

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-HPR-05	Display the details of planning in a clear way	To provide 3D modelling for displaying the details of planning in a clear way	This case describes how urban planners use CIM platform to visualize the heritage revitalization planning in 3D format. It is difficult for urban planners to envision the spatial form of heritage preservation and revitalization in multiple dimensions. The CIM platform can integrate different types of data and information in 3D format, which include land use, transportation facilities, building height, etc.	Urban planner, public resource manager, citizen, CIM platform and software developer, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-HPR-06	Making the planning easy to understand	To explain and display the planning in an easy way to understand	This case describes how urban planners use CIM platform to explain and display the planning. Stakeholders need to grasp some professional knowledge and skills to understand the planning. However, some stakeholders possibly do not satisfy these requirements, such as most of general public. CIM platform should provide a function of displaying in simplified way.	Urban planner, citizen, CIM platform and software developer, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-HPR-07	Data and information integration	To integrate different types of information in one platform and different types of stakeholders can access them	This case describes how developers use CIM platform to access different types of data and information and analyse them. Different types of information about heritage should be accessible for developers, which include quantity and type of population, the situation of owners, surroundings, and socioeconomic condition. It is helpful to calculate the cost of development and make a feasibility report when developers are submitting a tender for the land use of heritage programmes.	Real estate developer, urban planner, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-HPR-08	Provide the information of urban facilities	To provide the information of urban facilities on heritage revitalization planning	This use case describes how developers use CIM platform to access the data of civil facilities in the historical district on the planning and use them for analysis. These facilities include transport infrastructure, schools, health facilities, public park, etc., which are helpful for enhancing the value of local residential property and community. Developers need to have the information of all the existing and coming civil facilities and calculate their impacts on the value of the property.	Real estate developer, urban planner, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-HPR-09	Obtain the skills to use CIM platform for development planning	To obtain the skills to use the CIM platform for development planning	This use case describes how the developers obtain the skills to use the CIM platform to make effective planning on land use and present the planning multi-dimensionally. The developer has obtained the data of the urban planning in the CIM platform. The staff is trained to use the CIM.	Real estate developer, urban planner, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-HPR-10	Communicate with urban planning and development planning for a specific land	To communicate with urban planning and development planning for a specific land	This use case describes how the developers use the CIM platform to access the data and requirements of a specific land for development. The developer can obtain the data of the urban planning in CIM platform for their preparing, organizing, and submitting a development request for a specific land. The developer is authorized to edit the CIM platform and add information, especially including the building information modelling (BIM) for the specific land when the request is approved.	Real estate developer, urban planner, CIM platform, CIM online platform, data storage facility, CIM platform web server

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-HPR-11	A large amount of data exchange and process in real time	To exchange and process a large amount of data in multiple formats in real time	This case describes that the design team combine field data collection with data processing in real time. The design of historical buildings and districts should access the spatial data from field mapping. Designers use technology (BIM, GPS, GIS, and 3D laser scanning technology) to collect building surface point cloud data and upload them to the CIM platform in real time. Relevant designers use them to build a digital 3D model and instruct the work of field staff.	Project scheme designer, sensing equipment, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-HPR-12	Communicate with real estate registration department	To communicate with real estate registration department	This case describes how designers obtain the information of relevant owners. Designers use the CIM platform to obtain the situation of local owners to design the scheme of heritage revitalization and reduce the problems of owners due to the wrong solution. Designers can edit the data in the CIM platform to promote the attribute information of 3D model.	Project scheme designer, urban planning decision maker, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-US-HPR-13	Integrate different types of data	To integrate different types of data for construction of heritage database	This case describes that designers use CIM platform to build the database of historical heritage. The digital database plays an important role throughout the whole project of preservation and revitalization, which includes design scheme, construction, operation and maintenance. Designers can use the CIM platform to integrate different types of data for storage and correlation and use it to make updates to the database multi-dimensionally in an effective way.	Project scheme designer, urban planning decision maker, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-HPR-14	Carrying out research in different dimensions	To carrying out a research of heritage preservation and revitalization in different dimensions	This use case describes how the team of designers analyse the social situation of historical districts. Historical districts preservation and revitalization should consider the situation of heritage buildings and social ecosystem in local community, which includes age structure, family structure, distribution of residents, etc. Designers can understand local ecosystem and development through analysing this information, then make a suitable and sustainable scheme.	Project scheme designer, urban planning decision maker, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-HPR-15	User-friendly platform	To provide a user-friendly platform	This use case describes how designers use CIM platform to carry out spatial analysis. Professional software and hardware should carry out the spatial analysis. It is difficult to achieve all the spatial analysis methods in a platform or software. In addition, the processing of a number of data is another problem. CIM platform can provide different types of analysis methods and high capacity to process these problems in an easy way.	Project scheme designer, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-HPR-16	Scheme simulation	To simulate the scheme in the CIM platform	This use case describes how designers carry out the simulation and modelling of heritage preservation and revitalization. Designers need to model the historical buildings or districts, and simulate a variety of situations, which include housing structure, pipeline system, road network, shape design and so on. CIM platform can provide a function of 3D modelling which connects with database. It is convenient for designers to carry out theme design in a clear way.	Project scheme designer, CIM platform, CIM online platform, data storage facility, CIM platform web server

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-HPR-17	Collect the comments from different stakeholders	To collect the comments from different stakeholders for enhancing the scheme.	This use case describes the requirement of the comment function of the CIM platform. Designers should communicate with different stakeholders, which include the general public, companies, authorities, organizations which have their specific interest, different government departments, etc. at a different stage of the planning projects. They need to present the design and collect comments from different stakeholders. The web CIM platform can help almost all types of stakeholders to view and comment on the design.	Project scheme designer, urban planning decision maker, real estate developer, citizen, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-HPR-18	Investment evaluation	To obtain different types of data and information for investment evaluation	This use case describes that investors make the analysis and evaluation of investment based on a number of data and information. Heritage preservation and revitalization need a large amount of funding, in addition to government investment. Investors make the decision of investment by the analysis of development potential in the future. Investors use CIM platform to analyse relevant information, which includes socioeconomic condition, location, relevant planning, etc., and simulate different schemes to evaluate whether to invest. The association of heritage preservation and revitalization organized by the public also can use CIM platform to make the scheme of investment for effective distribution.	Local business owner, urban planner, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-HPR-19	Carrying out the research in different dimensions and topics	To carry out the research innovation in different dimensions and topics for promotion and innovation theory of heritage preservation and revitalization.	This use case describes that research institution uses CIM platform for promotion and innovation of theoretical research of heritage preservation and revitalization. Research institutions need a number of data and information as the base of research. It means that they need to communicate with different types of departments. CIM platform can provide a platform for research institutions to satisfy these requirements. In addition, the ability of analysis in different dimensions and tools is helpful for research institution to carry out the experiments which cannot be achieved in a common way.	Academic researcher, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-HPR-20	Comments from the perspective of business CEO	To obtain different types of data and information for commenting on heritage revitalization from the perspective of business CEO	This use case describes how business owners obtain different types of data of the planning and scheme of heritage preservation and revitalization, use them for analysis and make comments on the planning and scheme. The business owners can represent their willingness to move the business in the historical district. Fierce peer competition will drive up local rental prices. To some extent, the revitalization planning, and programme of historic district also affect the business environment. It is possible that shop owners pay more attention to the new business development mode and customer groups.	Local business owner, CIM platform, CIM online platform, data storage facility, CIM platform web server

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-HPR-21	Making the final decision	To obtain different types of data and information for making the final decision of moving	This use case describes how business owners obtain different types of data of historical district on the revitalization planning, use them for evaluation and make the final decision whether to move to the historical district. Relocation has some economic effects in short term and long term. The cost of relocation in the short term is not a small expense. In the long run, whether the expenses such as site leasing, water and electricity, taxes, material procurement and staff wages can be paid by income and make profits is an important basis for enterprises to evaluate the relocation decision.	Nonlocal business owner, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-HPR-22	Updating and promoting the database	To access different types of data and information for updating and promoting the database	This use case describes how operation team obtains different types of data for updating the database. Heritage databases have been one of the most important parts of digital protection and revitalization of historical buildings. In addition to all kinds of data collected during the construction of the project, the operation team needs to continuously collect building data and information in the later management, which include repair records, damage, relevant historical literature supplement, etc. It is helpful for protection, management, research, exhibition, update, planning, etc. if operation team has a relatively perfect heritage database.	Construction practitioner, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-HPR-23	Real-time monitoring	To connect sensor with CIM platform for the monitoring of regional environment and facilities	This use case describes how operation team monitors the environment in real time. Operation team needs to monitor the historical district and buildings included in the cultural heritage protection and revitalization for a long time. The factors of surroundings can affect the lifetime of historical buildings, which include temperature, humidity, corrosion, weather, mildew, etc. CIM platform needs to connect with different types of sensors for the real-time feedback of environmental changes so that staff can adjust the environmental condition. For example, they can use air conditioning system to adjust temperature and humidity by CIM system.	Construction practitioner, Sensing equipment, video equipment, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-HPR-24	Using sensor technology for maintenance and protection	To use sensor technology for effective maintenance and protection	This use case describes that operation team uses sensor technology for effective maintenance and protection. Sensor technology can be used to monitor the structure of heritage buildings, such as active radiofrequency identification (RFID) technology, Internet of Things technology, automatic control technology, etc. Through the monitoring of various structural parameters, real-time and accurate data collection of heritage buildings can be carried out, to realize the automatic and integrated monitoring of changes in heritage building components.	Construction practitioner, Sensing equipment, video equipment, CIM platform, CIM online platform, data storage facility, CIM platform web server

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-HPR-25	Protecting the living environment and habits for existing residents	To understand the heritage preservation and revitalization planning and protecting the living environment and habits for existing residents	This use case describes how local residents are involved in the heritage preservation and revitalization. The revitalization of historical districts directly affects the life of residents and some issues in the planning is worthy of wider public discussion. Residents want to understand the planning and scheme of heritage revitalization by using the CIM platform, estimate the impacts on their living environment and habits, make comments on the planning and present their requirement.	Local community member, urban planner, CIM online platform, data storage facility, CIM platform web server
CIM-UC-HPR-26	Selecting the community for new home	To understand the heritage revitalization planning and selecting the community for new home.	This use case describes how citizen who is going to move into the historical district is involved in revitalization planning. The household needs to consider the housing price, surroundings, relevant facilities, transportation situation, public facilities, etc. With the analysis of this information, they can make the final decision of moving and relocate to their new home.	Nonlocal community member, urban planner, CIM online platform, data storage facility, CIM platform web server
CIM-UC-HPR-27	Comment	To provide a function of comment	This use case describes how a tourist is involved in the heritage preservation and revitalization planning by making comments. Tourism is one of important driving force for heritage revitalization. A number of historical buildings and districts have become valuable tourist resources. The comments of tourists will influence the reputation of historical buildings and districts. Operation team can find the existing problems and promote the heritage preservation and service. It is helpful to provide an excellent experience to tourists.	Nonlocal community member, urban planner, CIM online platform, data storage facility, CIM platform web server
CIM-UC-HPR-28	Making a travel plan	To access different types of data and information for making a travel plan	This use case describes how tourists access the data of tourist sites and make their travel planning. Tourists need to access different types of data and information to understand the tourist sites and their surroundings, which include traffic situation, ticket booking, opening time, peak period of population, restaurant, etc. Tourists analyse this information and make suitable travel plans and routes according to their situation.	Nonlocal community member, urban planner, CIM online platform, data storage facility, CIM platform web server
CIM-UC-HPR-29	Making the final decision to approve the heritage revitalization planning and relevant policy	To estimate the planning based on the feedback from different stakeholders and to make the final decision to approve the heritage revitalization planning and relevant policy	This use case describes the role of government in making a heritage revitalization planning. Governments obtain the plan from urban planners, display the plan multi-dimensionally for the general public and make the final decision. Before the final decision of the heritage revitalization, governments need to display it for the general public and collect the feedback.	Construction project approval manager, urban planner, CIM online platform, data storage facility, CIM platform web server

5.8.2 Use case analysis

The application of city information modelling to heritage preservation and revitalization aims to: a) build heritage building information modelling; b) strengthen the link between the digital model and the physical realm of heritage assets; c) provide more effective learning and communication tool for the general public to increase their awareness of heritage preservation; d) support the preventive conservation and revitalization of heritage places.

The stakeholders of applying CIM to the heritage preservation and revitalization include urban planner (primary beneficiary, designer, user), real estate developer (secondary beneficiary, user, builder), project scheme designer (secondary beneficiary, user, builder), academic researcher (secondary beneficiary, designer), construction practitioner (secondary beneficiary, maintainer), business owner (tertiary beneficiary), general public (fourth beneficiary), government (owner, maintainer, designer). Urban planners play a critically important role to connect all the other stakeholders.

CIM serves as a giant data hub, central processing unit and communication platform in heritage preservation and revitalization. It is a massive data processing centre, visual analysis integrator, intelligent operation and maintenance centre, communication platform. First, CIM platform can store and manage different types of data from multiple departments and has huge capacity. Second, CIM integrates modern surveying and mapping, BIM, IoT, digital city and other technologies, and carries out a variety of data analysis in the form of three-dimensional model, which is beneficial for the government to make decisions, planners and designers to make more scientific and effective analysis. Third, the combination of CIM platform and IoT is helpful for the real time monitoring of the overall period of heritage preservation and revitalization project, such as surveying and mapping and environment monitoring. Finally, CIM platform allows more stakeholders to participate in the heritage revitalization for information flow.

Twenty-nine city information modelling use cases were collected in the application area of heritage preservation and revitalization regarding the stakeholders of the urban planner (6 use cases), real estate developer (4 use cases), project scheme designer (7 use cases) , academic researcher (1 use case), business owner (3 use cases), construction practitioner (3 use cases), general public (4 use cases), and government (1 use case) (Figure 15).

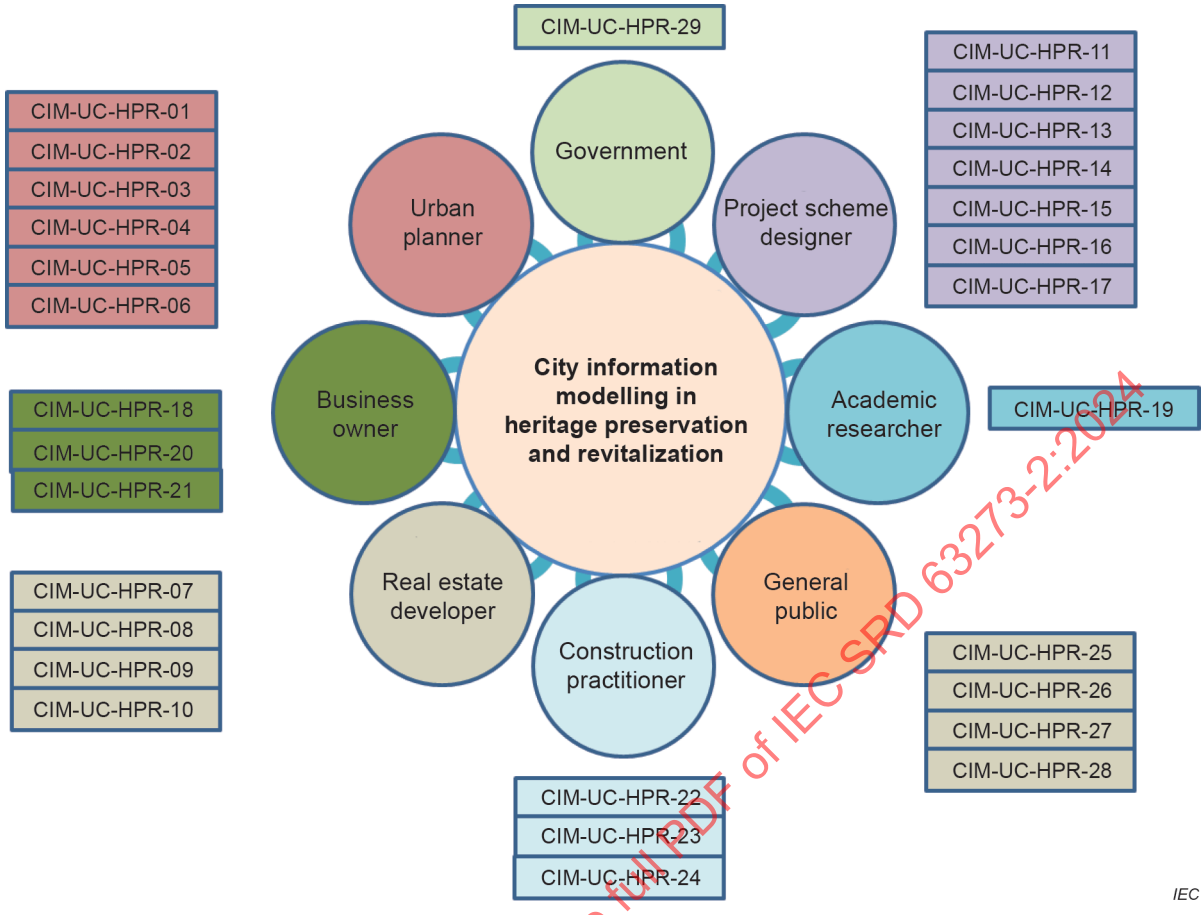


Figure 15 – Structure of use cases of applying city information modelling in heritage prevention and revitalization regarding stakeholders

The user stories and use cases serve different needs of applying city information modelling to heritage preservation and revitalization (Figure 16): a) the platform supports data collection, data management and data storage, which these data include different types of data and can be accessed in this platform (CIM-NS-HPR-01, 7 use cases); b) different types of heritage data and information need to be integrated, analysed with high precision and simulated for different themes of revitalization projects (CIM-NS-HPR-02, 6 use cases); c) the revitalization planning needs to be exhibited in a intelligible way, such as 3D modelling (CIM-NS-HPR-03, 4 use cases); d) heritage operation needs to be displayed in 3D format and be monitored in real time (CIM-NS-HPR-04, 1 use case); e) different stakeholders can effectively communicate with each other and comment on the heritage revitalization planning in a user-friendly platform (CIM-NS-HPR-05, 6 use cases); f) user with authorization can carry out different operations for their requirements without high level skills, which include uploading, downloading, and editing data (CIM-NS-HPR-06, 5 use cases).

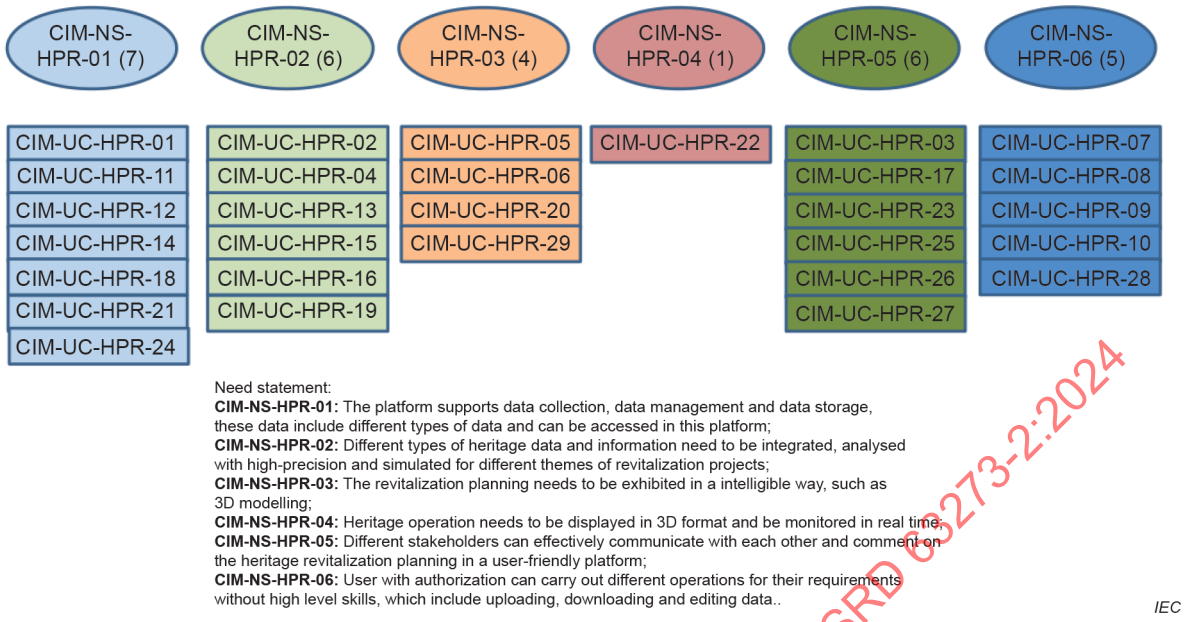


Figure 16 – Structure of use cases of applying city information modelling in heritage prevention and revitalization regarding needs statement

5.8.3 Requirements for the standards

The CIM standards when considering its application to heritage prevention and revitalization should consist of the requirements of different types of data, which include but are not limited to the format of the data. Moreover, the CIM standards should define different levels of permission and access for different users, which include but are not limited to level of project administrators, contributors, readers and commenters.

5.8.4 Related documents

- ISO 37156:2020, Smart community infrastructures – Guidelines on data exchange and sharing for smart community infrastructures
- ISO 37166:2022, Smart community infrastructures – Urban data integration framework for smart city planning (SCP)
- Technical guidelines for city information modelling (CIM) basic platform (China)

5.9 Transportation infrastructure planning

5.9.1 Use cases

See Table 8.

Table 8 – The use cases of applying city information modelling in transportation infrastructure planning

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-TIP - 01	Analysing the impact of infrastructure of transport development and taking correct measures to promote net-zero development	To assess the economic, environmental , and social impacts of the initiatives	This use case describes the role of officials of transport infrastructure planning in building transport links for economic development. Governments are constantly looking for ways to develop their road networks and other transport links to meet their economic, political and social needs. In some jurisdictions this will mean building brand new roads, in others it will mean focusing on refurbishing, widening and extending existing roads. It should also tackle net-zero while balancing trade-offs.	Official of transport infrastructure planning, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TIP - 02	Taking correct measures to mitigate the development	To take correct measures to mitigate the impact of development	This use case describes the role of officials of transport infrastructure planning in taking correct measures to mitigate the impact of development. The builder or maintainer is responsible for the management of roads, and public transportation, etc. New roads are expensive, and governments are often unable or unwilling to commit fiscal spending to roads. This is an area where project financing and public–private partnership projects are becoming more and more common.	Official of transport infrastructure planning, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TIP - 03	Understanding the new travelling possibilities	To understand the new travelling possibilities	This use case describes the role of officials of transport infrastructure planning in applying CIM to understand the new travelling possibilities.	Official of transport infrastructure planning, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TIP - 04	Building transport links for economic development	To understand the overall net-zero strategy and implementation plan	This use case describes the role of officials of transport infrastructure planning in applying CIM to understand overall net-zero strategy and implementation plan when building transport links for economic development.	Official of transport infrastructure planning, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TIP - 05	Involving public in modelling and decision making	To involve public in modelling and decision making prepare for taking correct measures to mitigate the impact of development	This use case describes the role of officials of environmental authorities in applying CIM to understand how the impacts created by involving public in modelling and decision making prepare for taking correct measures to mitigate the impact of development. Public involvement standard is a statement of good practice that describes the approach on which assessment of impacts the public should be involved in.	Official of transport infrastructure planning, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TIP - 06	Understanding the available data and relevant technology	To understand the available data and relevant technology	This use case describes the role of private infrastructure developer in making correct measures to mitigate the impact of development. New road is expensive. The private infrastructure developer wants to understand the available data and relevant technology, use them for making the correct measures to mitigate the impact of development.	Private infrastructure developer, CIM platform, CIM online platform, data storage facility, CIM platform web server

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-TIP - 07	Developing new transportation facilities	To understand the overall net-zero strategy and implementation plan	This use case describes the role of officials of transport infrastructure planning in applying CIM to understand overall net-zero strategy and implementation plan when developing new transportation facilities.	Private infrastructure developer, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TIP - 08	Examining transport infrastructure developments by officials of environmental authorities	To understand the impact created by the transport infrastructures development	This use case describes how the officials of environmental authorities use CIM as a tool to examine and understand the impact created by the transportation infrastructures.	Official of environmental authorities, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TIP - 09	Examining transport infrastructure developments by the officials of environmental authorities	To examine and understand the impacts created by new travelling possibilities	This use case describes how the officials of environmental authorities apply CIM to understand the impacts created by new travelling possibilities and take the correct measures to mitigate the impacts created by the development. Officials of environmental authorities are responsible for reducing emissions, building the capability and capacity required to inform decision-making; and maintaining public consent with meeting net-zero goals.	Official of environmental authorities, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TIP - 10	Reviewing and correcting approach being adopted	To understand the impact created by the transport infrastructures development	This use case describes how the officials of environmental authorities apply CIM to understand the impacts created by new transport infrastructure in order to review the current approach being adopted and correct it if needed.	Official of environmental authorities, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TIP - 11	Examining transport infrastructure develop-ments by utility services providers	To understand the impact created by the transport infrastructures development	This use case describes how the utility services provider uses CIM as a tool to examine and understand the impact created by the transportation infrastructures. It will help to provide basic necessities such as water, electricity, waste management, etc. to citizens.	Utility services provider, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TIP - 12	Estimating the price of the land	To understand the impacts created by the existing and new transport	This use case describes how the real estate developers use CIM to understand the impacts created by the existing and new transport infrastructure. They can estimate a price of the bidding land by using CIM and considering the impact of transport infrastructure.	Real estate developers, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TIP - 13	Citizens' involvement in the decision making relevant to new transport links	To allow communities to proactively plan, predict and prepare for develop-mental impacts	This use case describes how the citizens use CIM to participate in the decision making relevant to new transport links for economic development. Citizens are encouraged to participate in the public forums, official website to present their comments infrastructure proposal and to let their local government know of any concerns and appeals.	Citizen, official of transport infrastructure planning, CIM platform, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TIP - 14	Co-ordinating UN sustainable development goal	To allow communities to proactively plan, predict and prepare for develop-mental impacts	This use case describes how officials in United Nations – United Nations Framework Convention on Climate Change use CIM to coordinate the UN sustainable development goals. The UN's role is to assist and facilitate the net-zero standard. The coordination can enable more understanding on technical terms of the overall net-zero strategy and implementation plan.	Official in United Nations – United Nations Framework Convention on Climate Change, CIM platform, CIM online platform, data storage facility, CIM platform web server

5.9.2 Use case analysis

The application of CIM to transport infrastructure planning aims to: a) assess the economic, environmental, and social impacts of the initiatives; b) allow communities to proactively plan, predict and prepare for developmental impacts; c) achieve the larger institutional goals of net-zero and sustainable resource usage; d) improve the way data and inputs are utilized and how the overall process functions to keep pace with technological growth.

The stakeholders of applying CIM to transportation infrastructure planning include official of transport infrastructure planning (primary beneficiary, designer, and maintainer), private infrastructure developer (secondary beneficiary, designer, and user), official of environmental authorities (secondary beneficiary, designer, and user), utility service provider (secondary beneficiary, designer, and user), real estate developer (primary or secondary beneficiary, builder or user), citizen (tertiary beneficiary and user), and official in United Nations – United Nations Framework Convention on Climate Change (tertiary beneficiary and designer or user).

Fourteen city information modelling use cases were collected in the application area of transportation infrastructure planning regarding the stakeholders of the official of transport infrastructure planning (5 use cases), private infrastructure developer (2 use cases), official of environmental authorities (3 use cases), utility service provider (1 use case), real estate developer (1 use case), citizen (1 use case), and official in United Nations – United Nations Framework Convention on Climate Change (1 use case).

The user stories and use cases serve different needs of applying city information modelling to transportation infrastructure planning (Figure 18):

a) Policymakers and modelers are to deliver a plan for transitioning transport infrastructure modelling to a net-zero footing (CIM-NS-TIP-01);

b) Both public and private sector clients need to understand the availability of data, tools and the advancements happening in the industry (CIM-NS-TIP-02);

c) New mobility types, from the small-scales of ridesharing, bike-sharing, and shared scooters to autonomous vehicles and intraurban electric vertical take-off and landing (eVTOL) vehicles are planned to enter the mobility market in the next decade. There is a need to accommodate the new travelling possibilities within a set of rules and standards (CIM-NS-TIP-03).

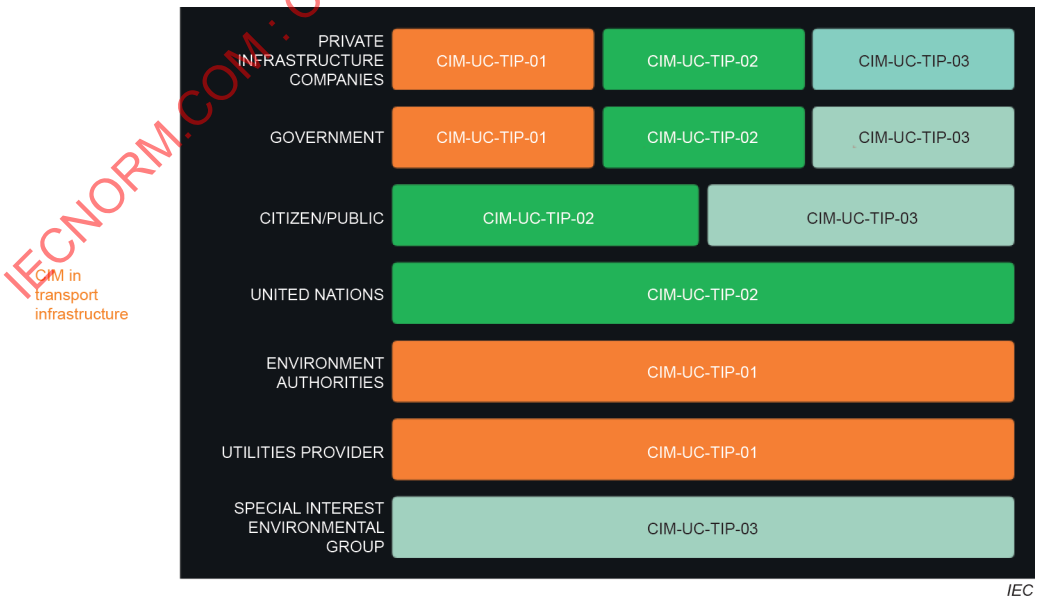


Figure 17 – Structure of use cases of applying city information modelling in transport infrastructure planning regarding stakeholders

CIM-NS-TIP-01	Policymakers and modellers are to deliver a plan for transitioning transport infrastructure modelling to a net-zero footing.	CIM-UC-TIP -01	Analyzing the impact of infrastructure of transport development and taking correct measures to promote net-zero development
CIM-NS-TIP-02	Both public and private sector clients need to understand the availability of data and tools and the advancements happening in the industry.	CIM-UC-TIP -01	Analyzing the impact of infrastructure of transport development and taking correct measures to promote net-zero development
CIM-NS-TIP-02	Both public and private sector clients need to understand the availability of data and tools and the advancements happening in the industry.	CIM-UC-TIP -01	Analyzing the impact of infrastructure of transport development and taking correct measures to promote net-zero development
CIM-NS-TIP-02	Policymakers and modellers are to deliver a plan for transitioning transport infrastructure modelling to a net-zero footing.	CIM-UC-TIP -01	Analyzing the impact of infrastructure of transport development and taking correct measures to promote net-zero development
CIM-NS-TIP-02	Policymakers and modellers are to deliver a plan for transitioning transport infrastructure modelling to a net-zero footing	CIM-UC-TIP -01	Analyzing the impact of infrastructure of transport development and taking correct measures to promote net-zero development
CIM-NS-TIP-03	New mobility types, from the small-scales of ridesharing, bike-sharing, and shared scooters to autonomous vehicles and intraurban electric Vertical Take-off and Landing (eVTOL) vehicles are planned to enter the mobility market in the next decade. There is a need to accommodate the new travelling possibilities within a set of rules and standards.	CIM-UC-TIP -01	Analyzing the impact of infrastructure of transport development and taking correct measures to promote net-zero development
CIM-NS-TIP-03	New mobility types, from the small-scales of ridesharing, bike-sharing, and shared scooters to autonomous vehicles and intraurban electric Vertical Take-off and Landing (eVTOL) vehicles are planned to enter the mobility market in the next decade. There is a need to accommodate the new travelling possibilities within a set of rules and standards.	CIM-UC-TIP -01	Analyzing the impact of infrastructure of transport development and taking correct measures to promote net-zero development

IEC

Figure 18 – Structure of use cases of applying city information modelling in transport infrastructure planning regarding needs statement

5.9.3 Requirements for the standards

Multiple data in different formats should be integrated in the CIM platform. Multiple users apply the CIM platform when they are involved in the transport infrastructure planning.

5.9.4 Related documents

Existing intelligent transportation infrastructure planning relevant standards:

- ISO/TR 16786:2015, Intelligent transport systems – The use of simulation models for evaluation of traffic management systems – Input parameters and reporting template for simulation of traffic signal control systems
- ISO 17572-1:2022, Intelligent transport systems (ITS) – Location referencing for geographic databases – Part 1: General requirements and conceptual model

5.10 Traffic management

5.10.1 Use cases

See Table 9.

Table 9 – The use cases of applying city information modelling in traffic management

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-TRM-01	Traffic accident data reporting	To urge law enforcement officers to deal with traffic accidents	This use case describes uploading the location information of a traffic accident to the CIM platform through crowd reporting and video surveillance equipment and marking its location in the digital city space. The traffic police can visit the location of the traffic accident through the CIM platform and obtain the route of arrival.	Traffic police, citizen, video equipment, mobile phone, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TRM-02	Traffic accident record	To make a preliminary judgment on a traffic accident	This use case describes that traffic police retrieve historical road section surveillance videos of traffic accidents on the CIM platform to understand the road section conditions before and after the accident and the cause of the accident, so as to make a more scientific and reasonable preliminary judgment.	Traffic police, video equipment, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TRM-03	Traffic accident punishment announcement	To warn residents to obey traffic rules	This use case describes the traffic police uploading the final judgment result of a traffic accident to the CIM platform. On the one hand, the punishment result is sent to the mobile device of the relevant personnel to implement the punishment decision, on the other hand, it can highlight areas where traffic accidents occur frequently to remind the driver to pay attention to driving safety.	Traffic police, citizen, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TRM-04	Tracking the whereabouts of illegal traffic offenders	To narrow the search scope of illegal traffic offenders	This use case describes the use of the CIM platform by traffic police to track the whereabouts of illegal traffic criminals. The traffic police read the video surveillance equipment at the location of the traffic accident, identify the image of the vehicle that caused the accident, and compare it with the video surveillance content of the surrounding road section during the corresponding period, in order to determine the vehicle's escape direction and analyse the potential area.	Traffic police, video equipment, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TRM-05	Reporting of traffic jam section information	To dredge traffic pressure in a timely manner	This use case describes that the traffic police read real-time video surveillance on the CIM platform, discover road congestion in time, and locate the location of the road section and the way of arrival. In addition, the traffic police can also analyse and form a traffic congestion solution based on the historical traffic flow data of the surrounding roads stored in the CIM platform, so as to effectively carry out on-site traffic dredging.	Traffic police, video equipment, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TRM-06	Simultaneous update of traffic jam information	To avoid aggravating traffic congestion	This use case describes that after the traffic police locate the congested road section on the CIM platform, they analyse the surrounding potential inbound road sections by using analysis tools, so that the information can be synchronized to the in-vehicle system to remind drivers to avoid the congested road section and related inbound road sections in advance.	Traffic police, in-vehicle system, CIM online platform, data storage facility, CIM platform web server

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-TRM-07	Distributing traffic law enforcement cases	To deal with traffic accidents in time	This use case describes the distribution of law enforcement cases by traffic command centre. On the CIM platform, traffic command centre manager conducts a one-screen view of the number and distribution of traffic pending enforcement cases and the location of existing traffic police, so as to facilitate the distribution of pending enforcement cases to the mobile phones of surrounding traffic police.	Traffic command centre manager, traffic police, mobile phone, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TRM-08	Improving traffic safety	To improve traffic safety	This use case describes how according to the time and location of historical traffic accidents, the head of traffic management department queries the environmental information at that location and time period on the CIM platform, analyses the cause of the accident with the help of manual and computer means, and simulates and forms a corresponding preliminary solution to improve travel safety.	Head of traffic management department, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TRM-09	Data collection on the current status of transportation facilities planning	To understand the current situation of transportation facilities planning points	This use case describes how the head of traffic management department reads the integrated road network, road facilities, historical road flow, historical traffic problem statistics and other information integrated in the CIM platform and carries out visualized traffic status analysis.	Head of traffic management department, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TRM-10	Demand analysis of transportation facilities planning	To analyse the matching of transportation facilities planning and residents' needs	This use case describes how to use the CIM platform to clarify the direction of transportation facilities planning. On the CIM platform, head of traffic management department analyses the distribution of planned land around the traffic planning facilities, the change trend of the permanent population, and the change trend of traffic travel modes to determine whether the planned facilities can meet the living and production needs of residents.	Traffic management planner, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TRM-11	Simulation and derivation of transportation facilities planning	To provide planning solution analysis function	This use case describes how to use the CIM platform to simulate and deduct transportation facilities planning. Traffic management planner uploads the completed traffic facility planning to the CIM platform, and conducts a quantitative analysis based on the scale, type and service capacity of the traffic planning facility, so as to make a preliminary judgment on the impact of the traffic planning facility after it is completed.	Traffic management planner, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TRM-12	Public announcement of transportation facilities planning	To provide public opinion consultation channel	This use case describes how the public participates in the planning of transportation facilities. Traffic management planner uploads the completed traffic facility planning plan to the CIM platform and opens the public consultation channel. Citizens can log on to the CIM platform to visually observe the planning indicators and the spatial relationship between the planned transportation facility model and surrounding building models and submit consultation opinions.	Traffic management planner, citizen, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TRM-13	Comparison of transportation facilities planning	To provide multi-scheme comparison function	This use case describes how to choose the best plan among multiple plans. Traffic management planner uploads multiple planning of the same land to the CIM platform and compares them visually on the same screen in order to choose a more reasonable planning.	Traffic management planner, CIM online platform, data storage facility, CIM platform web server

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-TRM-14	Daily transporta-tion	To find a suitable travel route	This use case describes how the local community members use the CIM platform to find a suitable driving route within in-vehicle system. Although two-dimensional travel navigation currently exists, by accessing three-dimensional model data, the three-dimensional scene of the driving road can be described, so that when local community members drive, they can accurately locate the destination.	Local community member, in-vehicle system, GPS system, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TRM-15	Providing parking guidance service	Avoiding penalties for illegal parking	This use case describes how the CIM platform provides parking guidance services for local community members. Local community members can view the parking conditions around the place in real time by using in-vehicle system, when they drive to the destination, including the parking area, the number of parking lots, and the location of parking spaces.	Local community member, in-vehicle system, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TRM-16	Public transportati on services	To optimize the public travel experience	This use case describes how the CIM platform provides public transportation services for local community members. Local community members can use their mobile phones to check public transportation routes and waiting time in real time, which is convenient for residents to control public transportation travel.	Local community member, mobile phone, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TRM-17	Shared bicycle service	To providing shared bicycle service	This use case describes local community members accessing the CIM platform through their mobile phone to read the distribution area, service range and cycling route of shared bicycles under their current location, so that they can find shared bicycles.	Local community member, mobile phone, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TRM-18	Travel service	To provide travel services for tourists	This use case describes nonlocal community members who travel accessing the CIM platform through mobile phones, visiting the city's tourist attraction model, clarifying the spatial location and travel route of the attraction, and carrying out travel.	Nonlocal community member, mobile phone, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TRM-19	Optimization of bus operation mode	To improve the service level of public transportation	This use case describes how a bus company chief executive uses the CIM platform to optimize the company's operating model based on the GPS system. The CEO reads the peak travel time and stop information on the CIM platform in order to find that it should reduce or increase the time for dispatching public vehicles in order to adjust the operating mode.	Bus company chief executive, public transportation company, GPS system, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TRM-20	Handling emergencies in public transporta-tion	To respond to emergencies of public transportation vehicles	This use case describes how a bus operations manager responds to bus emergencies. By connecting to the video monitoring equipment mounted on the bus, the internal monitoring video can be obtained in real time. Through the image recognition technology of the CIM platform, identify people or events that can threaten the safety of public transportation in the video, and remind the company's CEO to deal with it.	Bus operations manager, public transportation companies, video equipment, CIM online platform, data storage facility, CIM platform web server

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-TRM-21	Bus service optimization	To provide high-quality bus travel experience	This use case describes how a bus operations manager provides residents with high-quality bus travel services. By connecting to the GPS system of buses, the real-time location data is obtained, and the average speed of the vehicle and the time of arrival at each stop are calculated according to the moving time and distance. At the same time, the calculation results are simultaneously updated to the CIM platform to provide an information source for residents to inquire about bus travel services.	Bus operations manager, public transportation companies, GPS system, CIM online platform, data storage facility, CIM platform web server
CIM-UC-TRM-22	Multi-departmental business coordination in traffic law enforcement	To promote information sharing among stakeholders to improve law enforcement effectiveness	This use case describes that different stakeholders share information based on the CIM platform to improve traffic law enforcement efficiency. When it comes to traffic violations, command centre manager requires a technician in traffic law enforcement department to collect and analyse accident information by analysis tools. And the analysis results will be transmitted to traffic police mobile devices to assist traffic enforcement.	Technician in traffic law enforcement department, traffic command centre manager, traffic police, CIM platform, data storage facility, mobile devices, CIM platform web server
CIM-UC-TRM-23	Traffic facility operation supervision for maintenance	To ensure the daily operation of traffic equipment	This use case describes traffic facility daily operation supervision. Through the data interface, the real-time operation data of traffic equipment is imported into the CIM platform, which is convenient for traffic facility maintainer to retrieve or query data. Also, by setting the pre-warning value, an alarm is issued when the operating data reaches or is about to reach the pre-warning value to remind maintainers to carry out facilities maintenance。	Traffic facility maintainer, traffic facilities, CIM platform, data storage facility, CIM platform web server
CIM-UC-TRM-24	Online bus plan and adjustment	To generate a scientific bus planning route	This use case describes that bus company planners use the analysis tools of the CIM platform to adjust and improve bus route plan, including the adjustment of bus stops or routes. Also, bus company chief executive can consult the final bus plan to determine whether it is suitable for the company's development strategy.	Bus company planner, bus company chief executive, CIM platform, data storage facility, CIM platform web server

5.10.2 Use case analysis

The application of city information modelling (CIM) to traffic management aims to: a) provide real-time monitoring of urban traffic operation status; b) improve the level of urban traffic planning management and decision-making; c) establish business collaboration and information sharing channels among various stakeholders.

The stakeholders of applying CIM to traffic management include government, which contains traffic law enforcement department and traffic management department (primary beneficiary, maintainer and owner); public transportation companies (secondary beneficiary and user); and users in traffic (secondary beneficiary and user), which include drivers, cyclists and pedestrians. Government plays a critically important role to connect all the other stakeholders.

In traffic management, CIM serves as the basic data centre for government departments and as a communication platform for cross-departmental collaboration. It integrates basic geographic data from various departments and real-time dynamic data from sensor equipment to show the government the real-time status of the three-dimensional traffic operations and to provide government departments with traffic operation status monitoring, illegal traffic behaviour tracking, and traffic operation management technical service support.

At the same time, it can visually display the planning of transportation facilities to relevant stakeholders and collect their opinions, so as to adjust and improve the planning of transportation facilities. In addition, it can also provide information search and visual analysis tools for the public and bus company.

Twenty-four city information modelling use cases were collected in the application area of traffic management regarding the stakeholders of traffic law enforcement department (8 use cases), traffic management department (7 use cases), users in traffic (5 use cases), public transportation companies (4 use cases) (Figure 19).

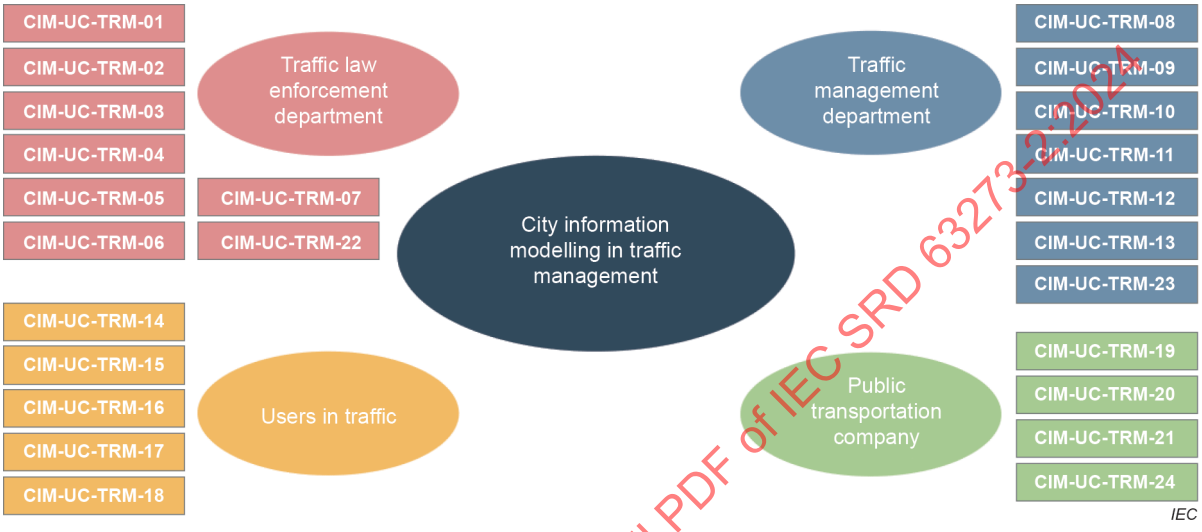


Figure 19 – Structure of use case of applying city information modelling in traffic management regarding stakeholders

The user stories and use cases serve different needs of applying city information modelling to traffic management (Figure 20): a) the situation of traffic events and the surrounding environment need to be understood in an intuitive and visual way (CIM-NS-TRM-01, 2 use cases); b) quantitative and visual analysis models need to be used to analyse the rationality of traffic solutions (CIM-NS-TRM-02, 7 use cases); c) different types of traffic data need to be merged into a unified platform to facilitate effective data search and acquisition (CIM-NS-TRM-03, 9 use cases) and d) a real-time synchronous update of multi-terminal traffic operating status data based on CIM platform needs to be built (CIM-NS-TRM-04, 6 use cases).

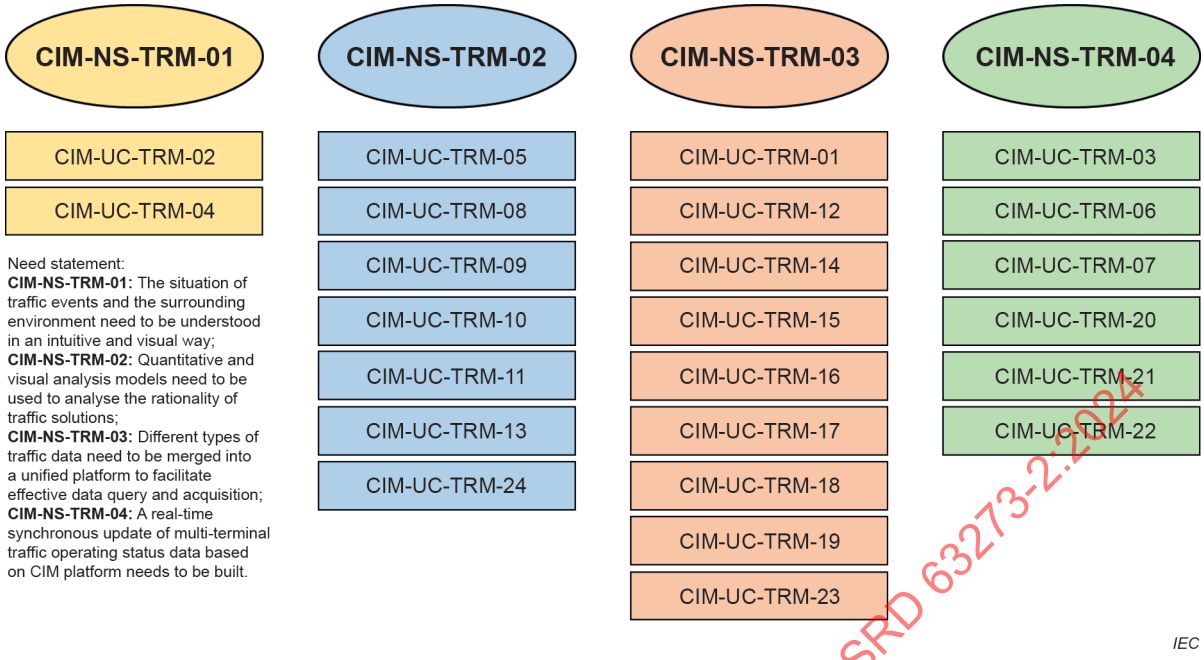


Figure 20 – Structure of use case of applying city information modelling in traffic management regarding needs statement

5.10.3 Requirements for the standards

- Video monitoring equipment data access standard
- CIM platform traffic data processing and application standard
- Data classification of applying CIM to traffic management
- Data dictionary of applying CIM to traffic management
- Traffic management data exchange and sharing based on CIM platform standard

5.10.4 Related documents

- ISO 37156:2020, Smart community infrastructures – Guidelines on data exchange and sharing for smart community infrastructures
- ISO 37166:2022, Smart community infrastructures – Urban data integration framework for smart city planning (SCP)
- Technical guidelines for city information modelling (CIM) basic platform (Published by Ministry of Housing and Urban-Rural Development of the People's Republic of China in September 2020)

5.11 Water management

5.11.1 Use cases

See Table 10.

Table 10 – The use cases of applying city information modelling in water management

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-WAM-01	A 3D water thematic model	To visually show the current status of the water environment	This use case describes that the water resources utilization planner can access the 3D water thematic model on the CIM platform to grasp the status of the water environment. By docking with urban water environment sensing equipment, such as water level monitors and water quality monitors, the monitoring data related to the water environment are collected regularly and superimposed with the 3D real scene model on the CIM platform to form a 3D water thematic model. Water resources utilization planners can inquire about the status of the water environment as needed.	Water resources utilization planner, sensing equipment, CIM platform developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-WAM-02	Analysis of current water environment	To develop a targeted water utilization plan	This use case describes the water resources utilization planners using the CIM platform to analyse the collected water environment related data. It is possible that planners do not have programming, modelling or simulation capabilities. The CIM platform needs to provide easy-to-operate and easy-to-understand visual analysis tools to assist planners in analysing the status quo of the water environment.	Water resources utilization planner, CIM platform developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-WAM-03	Water resources utilization planning assessment	To obtain an effective and reasonable water resource utilization plan	This use case describes how water resources utilization planners use CIM to select a suitable water resource utilization plan. The rationality assessment of water resources utilization requires the use of different types of data, such as water network pipelines, regional population, and industry types. The CIM platform can integrate the result data of different government departments and superimpose them with the three-dimensional model to form a three-dimensional database.	Water resources utilization planner, CIM platform developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-WAM-04	Simulation of water resources utilization plan	To visualize the results of water use	This use case describes how water resources utilization planner uses the CIM platform to model deductions for water resources utilization plans. For example, planners can rely on the evaluation model to measure the maximum urban water supply that can be provided under different water resource utilization conditions. The CIM platform should also provide the flexibility to revise the parameters and have the new outcomes efficiently.	Water resources utilization planner, CIM platform developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-WAM-05	Flood disaster impact analysis	To locate high-frequency flood disaster areas	This use case describes the flood disaster prevention thematic analysis module of the CIM platform. Flood control dispatchers can retrieve historical data of flood disasters on the CIM platform, observe and analyse areas with high frequency in historical periods, and take corresponding preventive measures in advance to improve the safety of residents' lives.	Flood control dispatcher, CIM platform developer, CIM online platform, data storage facility, CIM platform web server

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-WAM-06	Flood disaster monitoring	To provide the data access function of the sensing device	This use case describes the function of CIM platform docking with other devices to access data in real time. When the CIM platform only describes the status quo of the water environment and cannot realize real-time access to real-world water environment monitoring data, its ability to support water management decision-making will be greatly weakened. Developers need to specify a unified CIM platform development interface to achieve real-time access to monitoring data.	Flood control dispatcher, CIM platform developer, CIM platform CIM online platform, data storage facility, CIM platform web server
CIM-UC-WAM-07	Flood disaster plan generation	To provide easy-to-operate flood disaster solution analysis function	This use case describes the development of easy-to-operate analysis functions by developers based on urban water environment safety management requirements to assist managers in dealing with flood disasters. Developers form a set of flexible and configurable analysis models by integrating terrain, surface elevation, river water level, soil quality, and permeability coefficient parameters. Flood control dispatchers can analyse the feasibility of flood disaster solutions by adjusting parameters.	Flood control dispatcher, CIM platform developer, CIM platform CIM online platform, data storage facility), CIM platform web server
CIM-UC-WAM-08	Inter-departmental collaboration	To realize cross-departmental information sharing	This use case describes the sharing of water monitoring data among different departments on the CIM platform. Part of the water management work can involve multiple subjects depending on the division of functions. Therefore, cross-departmental information sharing of the same job will help the water resources utilization planner to execute the job.	Water resources utilization planner, water law enforcement agency, CIM platform developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-WAM-09	Obtaining construction data of water conservancy projects	To supervise the construction of water conservancy projects	This use case describes the docking of the CIM platform with the construction site monitoring equipment to collect project construction data on a regular basis. Through a unified platform interface, call the construction progress, construction environment, construction equipment, construction materials and other data of the on-site information system to assist project construction supervision.	Water conservancy project construction management personnel, sensing equipment, video equipment, CIM platform developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-WAM-10	Water law enforcement	To establish a water illegal supervision network	This use case describes the integration of the CIM platform and monitoring videos to improve the monitoring network for water violations in key water areas and use illegal punishment methods to alert the public to carry out water-related work in accordance with the law and protect the water environment.	Water law enforcement inspector, citizen, video equipment, CIM platform developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-WAM-11	Information sharing between departments	To effectively improve the efficiency of mobile law enforcement	This use case describes inter-departmental data interworking across time and space. Developers develop the mobile port of the CIM platform to facilitate water law enforcement inspectors to receive real-time information on illegal activities, spatial locations, and illegal personnel during the mobile law enforcement process, thereby improving the efficiency of mobile law enforcement.	Water law enforcement manager, water law enforcement inspectors, CIM platform developer, mobile phone, CIM online platform, data storage facility, CIM platform web server

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-WAM-12	Division of key law enforcement areas	To improve the effective use of law enforcement resources	This use case describes how to use the CIM platform to optimize the allocation of law enforcement resources. Water law enforcement managers use the easy-to-operate analysis tools in the platform to perform spatial analysis on historical law enforcement data, identify areas where high-frequency violations occur, and carry out key deployment of law enforcement resources in this area.	Water law enforcement manager, CIM platform developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-WAM-13	Water conservancy project construction management	To grasp the construction situation of water conservancy projects	This use case describes the function of the CIM platform to interface with different devices. Through the docking of the platform and the application managed by the site personnel, the monitors loaded on the construction equipment, the environmental monitoring instrument, and the video equipment, real-time construction information on the construction site can be obtained.	Project progress manager of water engineering construction company, CIM platform developer, video equipment, sensing equipment CIM online platform, data storage facility, CIM platform web server
CIM-UC-WAM-14	Construction period adjustment	To provide parametric analysis function	This use case describes the parametric analysis function of the CIM platform in the construction management topic. Developers integrate information such as construction personnel, construction equipment, and construction materials that can affect construction progress and construction safety to form a flexible and configurable analysis tool. The project progress manager of water engineering construction company can adjust different parameters and analyse the safety and duration of the construction.	Project progress manager of water engineering construction company, CIM platform developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-WAM-15	Construction adjustment plan generation	To meet the need to complete the project on schedule	This use case describes how to use the CIM platform to generate an implementable construction adjustment plan. In the construction process of water conservancy projects, there can be problems of lagging behind schedule caused by uneven deployment of personnel, lack of equipment, and material delays or the need for adjustment of project schedule. Developers need to consider the possibility of unexpected situations and develop flexible engineering quantity analysis and calculation functions to provide support for construction plan adjustments. Project progress manager of water Engineering Construction Company can use this analysis function to clarify how to carry out effective construction plan adjustments.	Project progress manager of water engineering construction company, CIM platform developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-WAM-16	Construction safety supervision	To build a safe construction environment	This use case describes how to analyse the safety level of engineering construction on the CIM platform. On the CIM platform, project safety officer of water engineering construction company can analyse the material, structure, and earthquake resistance of the water conservancy project model, and judge the stability of the project. Developers need to develop functions that can simulate construction methods to help managers predict whether there are unpredictable risks during the construction process.	Project safety officer of water engineering construction company, CIM platform developer, CIM online platform, data storage facility, CIM platform web server

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-WAM-17	Construction safety plan generation	To guide the construction workers to work safely	This use case describes how to use the CIM platform to generate a safe construction plan. The CIM platform integrates historical data of different types of security event processing. Developers need to develop construction safety hazard analysis results to compare and analyse the types of safety events, determine which type of safety event the hazard belongs to, and retrieve historical information about similar safety event handling methods. Project safety officer of water Engineering Construction Company can refer to the handling methods of similar safety incidents to guide the construction workers in safe construction.	Project safety officer of water engineering construction company, CIM platform developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-WAM-18	Water supply capacity assessment	To guarantee urban water	This use case describes water resources utilization planners using the CIM platform to master the city's water supply capacity. The director of water works installs sensing devices in the water pump room, water delivery pipe network, and water distribution pipe network of the water plant, the measured water volume of the main water supply equipment is transmitted to the CIM platform through the interface. Planners can query the water supply capacity of different water plants in the city on the CIM platform to ensure that they match the city's water demand.	Director of water works, water resources utilization planners, sensing equipment, CIM platform developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-WAM-19	Water supply quality monitoring	To provide qualified water resources	This use case describes how to use the CIM platform to automatically monitor the quality of source water. According to water quality monitoring standards, developers have developed some tools that can automatically compare the microbial content in water resources with water quality indicators and provide early warning of abnormal content indicators in water sources. When there is an early warning in water quality monitoring, water intake supervisor can retrieve the video monitoring data of the past month through the CIM platform to determine whether there is the possibility of man-made pollution of the water source.	Water intake supervisor, video equipment, CIM platform developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-WAM-20	Adjustment of water works business model	To promote the matching of water supply capacity with demand	This use case describes how to use the CIM platform to adjust the operation mode of a water plant. Due to the differences in regional demographic composition, occupational types, and building properties, there will be differences in the time period and amount of water used. The director of water works can query the main group information in the water supply area on the CIM platform, estimate the water use period and water consumption, and guide the adjustment of the water works' operating mode.	Director of water works, CIM platform developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-WAM-21	Flood disaster simulation	To provide visualization of the evolution of flood disasters	This use case describes how to use the CIM platform to visualize flood disasters. Developers develop the flood inundation simulation function, which dynamically simulates the changes in the flood inundation range over time according to rainfall, topography, and drainage coefficient. Residents can check the possibility of flooding in the residential area on the CIM platform and prepare for flood prevention in advance.	Citizen, CIM platform developer, CIM online platform, data storage facility, CIM platform web server

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-WAM-22	Collection of public opinions on project construction	To provide the function of collecting public opinions on engineering construction	This use case describes residents participating in water conservancy project planning and expressing opinions on the CIM platform. The project progress manager of water engineering construction company uploads the approved 3D engineering model on the CIM platform. Residents browse the engineering model on the CIM platform, evaluate the impact of the project on the living environment, and submit feedback.	Citizen, project progress manager, CIM platform developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-WAM-23	Water environmental protection	To provide law enforcement officials with information on illegal activities	This use case describes residents using the CIM platform to provide information on water violations. Developers develop mobile apps for illegal acts of collecting water from citizens. Residents can upload the illegal activities and location descriptions they see to the mobile application and share them on the CIM platform. Water law enforcement, inspectors can consult the reported violation information on the CIM platform to carry out law enforcement.	Citizen, law enforcement inspector, mobile phone, CIM platform developer, CIM online platform, data storage facility, CIM platform web server
CIM-UC-WAM-24	Ecological protection of rivers and lakes	To protect the ecological environment of rivers and lakes.	This use case describes how river and lake manager supervises the ecological environment of rivers and lakes. By setting up water quality monitoring equipment at the main drainage outlets of rivers and lakes, the content of various pollutants is analysed in each drainage in real time, and its outcomes are transmitted to the CIM platform. Compared with the pollutant warning value, an early warning notice is sent to managers. And according to the spread of water flow and other factors, the location of pollutant discharge will be tracked back.	River and lake manager, water quality monitoring equipment, CIM platform, data storage facility, CIM platform web server
CIM-UC-WAM-25	River shoreline supervision	To make plans based on changes in the river shoreline	This use case describes how river and lake manager makes plans based on the changes of river shorelines over the years. According to these changes, the corrosion and accumulation trends of the river shoreline are analysed. Based on the analysis result, the platform will display the simulated river shoreline in the next five to ten years to assist managers formulating corresponding defence measures or utilization plans.	River and lake manager, CIM platform, data storage facility, CIM platform web server
CIM-UC-WAM-26	Project quality process information collection	To collect the quality inspection data of the whole process of the project.	This use case describes how the engineering quality inspector collects quality inspection data during the construction process. They use mobile phones, flats, and other handheld devices to take photos of detected quality problems and upload them to the CIM platform through the interface.	Engineering quality inspector, CIM platform, data storage facility, CIM platform web server
CIM-UC-WAM-27	Project completion quality review	To ensure that the completed project meets quality requirements.	This use case describes the quality review of the completion of the project by the project quality inspector. By linking the collected process quality problem information to the corresponding engineering model, a construction process quality control model is formed. The quality inspector inquires and locates historical quality problems and conducts a quality review to determine whether the quality problem has been rectified.	Engineering quality inspector, CIM platform, data storage facility, CIM platform web server

5.11.2 Use case analysis

The application of city information modelling (CIM) to water management aims to: a) establish a city-wide water environment monitoring network; b) promote cross-departmental cooperation; c) provide quantitative and visual water environment analysis models; d) facilitate the communication between different stakeholders.

The stakeholders of applying CIM to water management include water management department (primary beneficiary, owner and maintainer), water law enforcement agency (primary beneficiary and user), water engineering construction company (user), water works (user) and citizen (secondary beneficiary and user). Water management department plays a critically important role to connect all the other stakeholders.

In water management, CIM serves as a basic data centre for government departments and as a communication platform for cross-departmental collaboration. It integrates basic geographic data from various departments and real-time dynamic data from sensor equipment, displays the three-dimensional water environment status to the government, and provides real-time monitoring of water quality and water supply capacity, so that managers can formulate reasonable and effective water resources utilization plans. At the same time, the CIM platform can provide simulation and analysis tools for flood disaster prevention and treatment, and water construction project management.

In addition, the CIM platform also provides information query and special analysis functions for water engineering construction companies and water works and provides the public with channels for water construction project planning opinions consultation and water pollution behaviour information collection.

Twenty-seven city information modelling use cases were collected in the application area of water management regarding the stakeholders of water management department (11 use cases), water law enforcement agency (3), water engineering construction company (7), water works (3), citizen (3) (Figure 21).

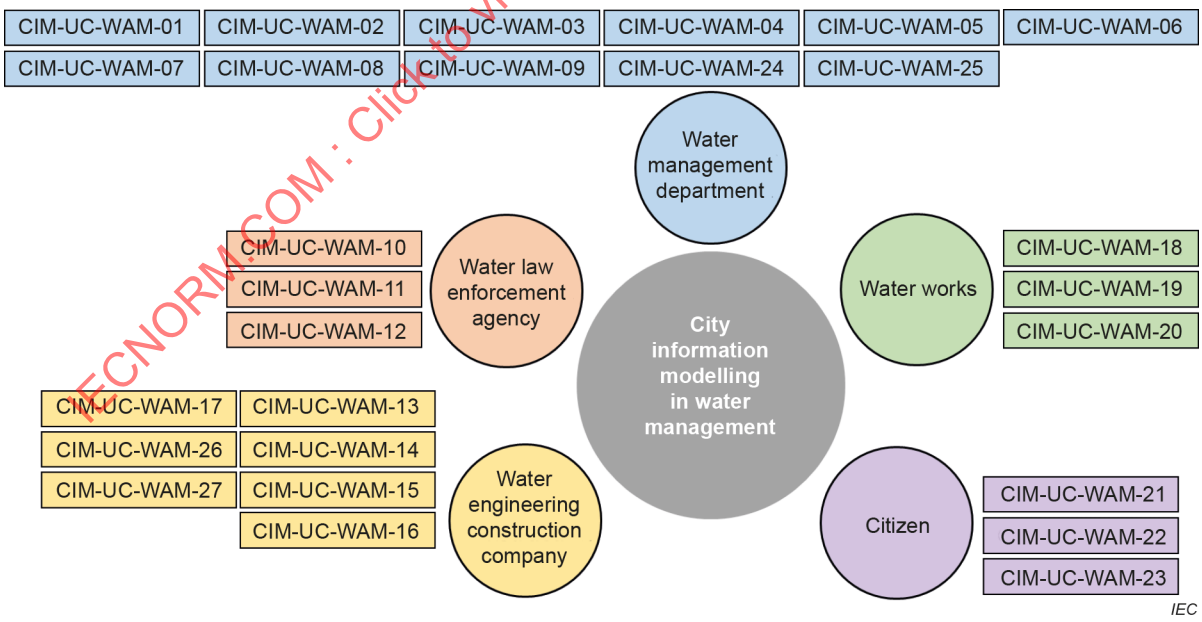


Figure 21 – Structure of use cases of applying city information modelling in water management regarding stakeholders

The user stories and use cases serve different needs of applying city information modelling to water management (Figure 22): a) different types of water management relevant data need to be put into one platform for efficient data query and acquisition (CIM-NS-WAM-01, 9 use cases); b) the current situation of the water environment management needs to be visually displayed and monitored in real time (CIM-NS-WAM-02, 4 use cases); c) the planning needs to be expressed in an easy-to-understand way (CIM-NS-WAM-03, 6 use cases); d) different stakeholders need to check and comment the new town planning in a user-friendly platform (CIM-NS-WAM-04, 5 use cases); and e) the authorized groups need to acquire, upload, download, and edit the data in the platform without high skill requirement (CIM-NS-WAM-05, 3 use cases).

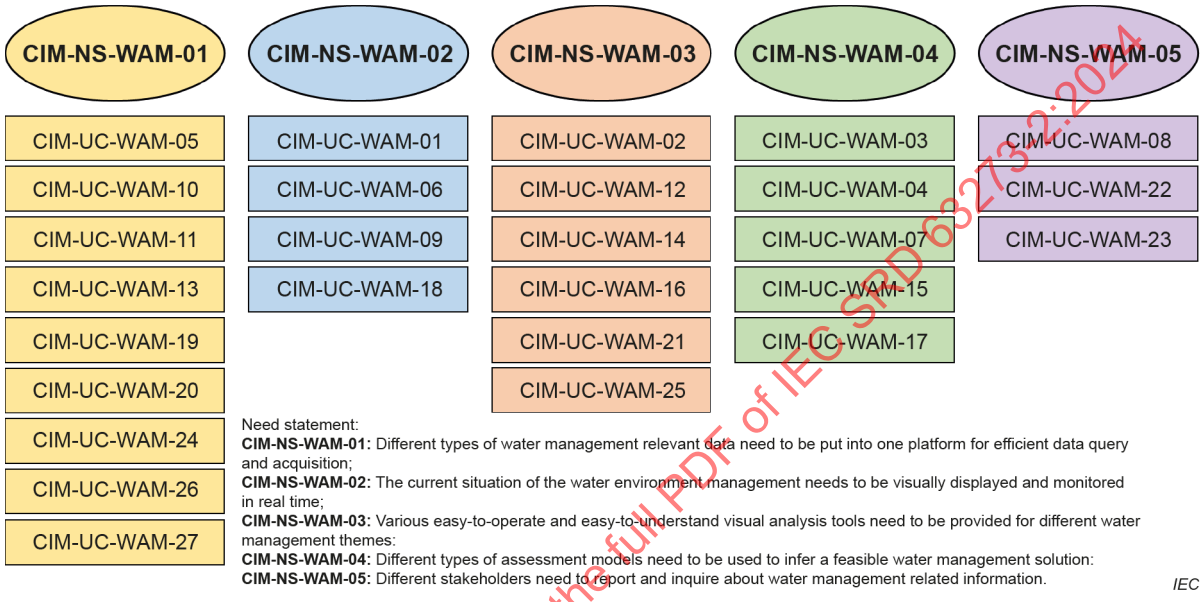


Figure 22 – Structure of use cases of applying city information modelling in water management regarding needs statement

5.11.3 Requirements for the standards

- Device data access standard, including sensing equipment and video equipment.
- CIM platform on the processing and application standards of water thematic data.
- Data classification of applying CIM to water management.
- Data dictionary of applying CIM to water management.
- Water management data exchange and sharing based on CIM platform standard.

5.11.4 Related documents

- ISO 37156:2020, Smart community infrastructures – Guidelines on data exchange and sharing for smart community infrastructures
- ISO 37166:2022, Smart community infrastructures – Urban data integration framework for smart city planning (SCP)
- Technical Guidelines for CIM Basic Platform (Published by Ministry of Housing and Urban-Rural Development of the People's Republic of China in September 2020)

5.12 Smart census project

5.12.1 Use cases

See Table 11.

Table 11 – The use cases of applying city information modelling in smart census project

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-SCP-01	Conducting population and census survey	To establish a modern way of achieving census within reduced budget, at a regular interval, enhanced data analysis and overcome cumbersome census manpower demand with processing constraints.	This use case describes how the officials of census department use CIM to conduct the population and census survey. Financing for census can be diverted to address COVID-19 and economic crisis, leaving census without crucial funds. A census aims to count the entire population of a country, and at the location where each person usually lives. The census asks questions of people in homes and group living situations, including how many people live or stay in each home, and the sex, age and race of each person. It is possibly well past time to consider the implications of CIM on the execution of our census beyond 2020. And what that means for our society. Census deserves accurate counts of our population, but it is maybe time for an upgrade via another way to build in order to achieve a much better and evolving census – the smart census.	Official of census statistical department, citizen, CIM platform, data storage facility, CIM online platform, CIM platform web server
CIM-UC-SCP-02	Improving assurance and confidence in smart census	To improve assurance and confidence in smart census	This use case describes how the officials of census department use CIM to develop a numerical profile of human capital of a nation. Ensuring confidentiality is crucial for the census to succeed. Thus, it shall be made clear that the only reason for collecting individual data is for the production of statistics, and that there will be no dissemination of individual information or any non-statistical linkage with existing records in other government databases and data collections.	Official of census statistical department, citizen, CIM platform, data storage facility, CIM online platform, CIM platform web server
CIM-UC-SCP-03	Producing more frequent and timely statistics	To produce more frequent and timely statistics	This use case describes how the officials of census department use CIM to understand the wider economic and social impacts of the decisions and policies from the ground. With the explosion of big data types and sources, the real value of using the synthetic "smart census" models has increased quite substantially. There are several positive applications of this type of smart census modelling that potentially benefit society, governments, healthcare, businesses to improve the economy, employment, housing, living standards, quality of life, mobility, safety, clean environment and many other aspects.	Official of census statistical department, citizen, CIM platform, data storage facility, CIM online platform, CIM platform web server
CIM-UC-SCP-04	Ensuring the smart census meets specified technical standard	To establish a modern way of achieving census within reduced budget, at a regular interval, enhanced data analysis and overcome cumbersome census manpower demand with processing constraints	This use case describes how the officials of census department use CIM to establish a modern way of achieving census within reduced budget, at a regular interval, enhanced data analysis and overcome cumbersome census manpower demand with processing constraints. With the COVID-19 pandemic and an increasing demand of countries' budgetary condition, many conducts of censuses of population and housing will be threatened in many countries through delays, interruptions that compromise quality, or complete cancellation of census projects. Financing for census can be diverted to address COVID-19 and economic crisis, leaving census without crucial funds.	Official of census statistical department, citizen, CIM platform, data storage facility, CIM online platform, CIM platform web server

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-SCP-05	Automated coding procedure on the smart census which meets specified technical standard	To understand and establish the automated coding procedure on the smart census which meets specified technical standard	This use case describes how the officials of census statistical department use CIM to understand and establish the automated coding procedure on the smart census which meets specified technical standard. The adoption of new methods and technology can reduce the operation and financial demands of a typical census through providing more standardized, controlled outputs.	Official of census statistical department, citizen, CIM platform, data storage facility, CIM online platform, CIM platform web server
CIM-UC-SCP-06	Engaging the hard-to-count population supply.	Underpin better and more reliable decisions on infrastructure and city services through scientific means of measuring the demand and supply	This use case describes how the officials of census statistical department use CIM to engage the hard-to-count population and follow the standard specification.	Official of census statistical department, citizen, CIM platform, data storage facility, CIM online platform, CIM platform web server
CIM-UC-SCP -07	Doing land-use planning for economic development	To underpin better and more reliable decisions on infrastructure and city services through scientific means of measuring the demand and supply	This use case describes how the officials of public development agency use CIM to have accurate and reliable assessment of population and land use. The adoption of new methods and technology can reduce the operation and financial demands of a typical census through providing more standardized, controlled outputs.	Official of public development agency, citizen, CIM platform, data storage facility, CIM online platform, CIM platform web server
CIM-UC-SCP -08	Understand the wider economic and social impacts of the decisions and policies from the ground	To understand the wider economic and social impacts of the decisions and policies from the ground	This use case describes how the officials of public development agency use CIM to understand the wider economic and social impacts of the decisions and policies from the ground. With the explosion of big data types and sources, the real value of using the synthetic "smart census" models has increased quite substantially. There are several positive applications of this type of modelling that potentially benefit society, governments, healthcare, businesses to improve the economy, employment, housing, living standards, quality of life, mobility, safety, clean environment and many other aspects. This is the true integrated environment going down to the synthetic person level of which nearly every element such as transport, housing, education, water, power, etc will be relied on.	Official of public development agency, citizen, CIM platform, data storage facility, CIM online platform, CIM platform web server
CIM-UC-SCP-09	Examining relevant information and discovering resources	To examine relevant information and discover resources	This use case describes how the officials of public development agency use CIM to examine relevant information and discover resources.	Official of public development agency, citizen, CIM platform, data storage facility, CIM online platform, CIM platform web server

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-SCP-10	Using smart census to test new business models, public policies, growth plans and economic impacts	Using smart census to test new business models, public policies, growth plans and economic impacts	This use case describes how the smart cities/net-zero businesses owners use CIM to understand the smart census and to test new business models, public policies, growth plans and economic impacts.	Smart cities/net-zero businesses owner, citizen, CIM platform, data storage facility, CIM online platform, CIM platform web server
CIM-UC-SCP-11	Build smart capabilities to meet the current demands	To build smart capabilities to meet the current demands	This use case describes how the smart cities/net-zero businesses owners use CIM to build smart capabilities to meet the current demands. This can help the smart cities/net-zero businesses owners adopt correct measures in making business decisions.	Smart cities/net-zero businesses owner, citizen, CIM platform, data storage facility, CIM online platform, CIM platform web server
CIM-UC-SCP-12	Understanding where the current and immediate future population mobility trend	To understand where the current and immediate future population mobility trend	This use case describes how the manager of a public transportation company uses CIM to understand where the current and immediate future population mobility trend and where any improvements should be.	Manager of a public transportation company, CIM platform, data storage facility, CIM online platform, CIM platform web server

5.12.2 Use case analysis

The application of city information modelling to smart census project aims to:

a) establish a modern way of achieving census within reduced budget, at a regular interval, enhanced data analysis and overcome cumbersome census manpower demand with processing constraints. The traditional census is among the most complex and massive exercises a nation undertakes. It requires mapping the entire country, mobilizing and training an army of enumerators, conducting a massive public campaign, canvassing all households, collecting individual information, compiling vast amounts of completed questionnaires and analysing and disseminating the data;

b) understand the wider economic and social impacts of the decisions and policies from the ground;

c) allow communities to proactively plan, predict and prepare for developmental impacts;

d) use smart census to test new business models, public policies, growth plans and economic impacts;

e) underpin better and reliable decisions on infrastructure and city services through scientific means of measuring the demand and supply;

f) produce more frequent and timely statistics;

g) improve assurance and confidence in smart census;

h) drive down reluctance of the population to participate in the census; and

i) increase technical capacities to manipulate data sources.

The stakeholders of applying CIM to the smart census project include official of census statistical department (primary beneficiary and owner), official of public development agency (secondary beneficiary, builder), smart cities/net-zero businesses owner (secondary beneficiary), and manager of a public transportation company (tertiary beneficiary) (Figure 23).

Twelve city information modelling use cases were collected in the application area of smart census project regarding the stakeholders of official of census statistical department (6 use cases), official of public development agency (3 use cases), smart cities/net-zero businesses owner (2 use cases), and manager of a public transportation company (1 use case) (Figure 24).

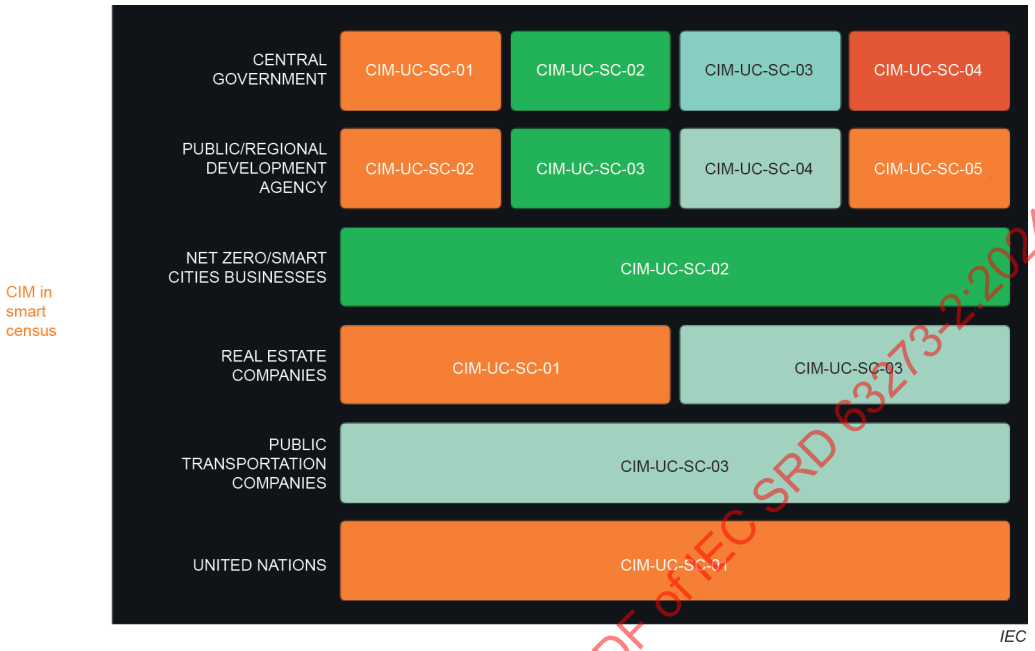


Figure 23 – Structure of use cases of applying city information modelling in smart census project regarding stakeholders

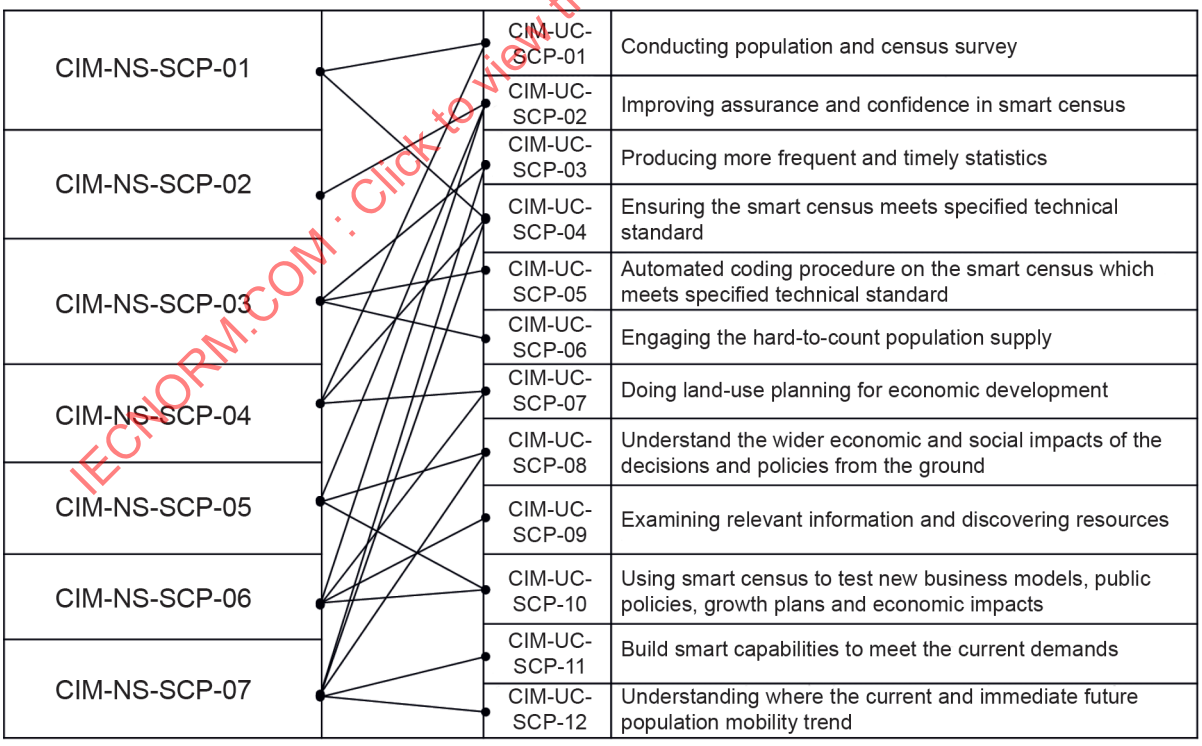


Figure 24 – Structure of use cases of applying city information modelling in smart census project regarding needs statement

NOTE CIM-NS-SCP-01: Human capital is the most critical capital for contemporary societies' well-being and progress. Providing an accurate and reliable assessment of this capital at small-area, regional and national levels is

of paramount value for evidence-based action by governments, civil societies, academics, researchers, and other stakeholders; CIM-NS-SCP-02: Ensuring confidentiality is crucial for the smart census to succeed. A standard addressing confidentiality and data collection can make clear that the collection of individual data is to produce statistics, and that there will be no dissemination of individual information or any non-statistical linkage with existing records in other government databases and data collections; CIM-NS-SCP-03: The need to produce more frequent and timely smart census statistics rather than the current five- or ten-year gaps to meet the needs of the population and climate change; CIM-NS-SCP-04: New metadata standards in census can be defined to facilitate the rise of alternative methods in mathematically deriving the smart census; CIM-NS-SCP-05: Traditional censuses are large operations with massive quantities of data that require coding and editing. To reduce the staff resources required and to improve timeliness, uniformity and accuracy, some countries have already implemented automated coding procedures for addresses, countries, education, occupation, and industry. There can be a global standard effort to set the available standards and new ones for smart census; CIM-NS-SCP-06: Assurance and anticorruption. The adoption of new methods or technology can reduce the risk of fraud or corruption through providing more standardized, controlled and auditable records of actions, for example for the records of financial expenditure; CIM-NS-SCP-07: Hard to count population. Authorities have a responsibility to engage fully with the communities they serve. The hard-to-count population can be the ethnic minorities, the homeless, etc. Failing to engage or count these groups can come at a cost – to finances, reputation, resources and, most tragically, to lives. Standard of engagement can be defined.

5.12.3 Requirements for the standards

The platform should integrate numerous different types of data for multiple purposes. It also provides timely statistics.

5.12.4 Related documents

- ISO 17572-1:2022, Intelligent transport systems (ITS) – Location referencing for geographic databases – Part 1: General requirements and conceptual model

5.13 Urban underground pipeline management based on data lake

5.13.1 Use cases

See Table 12.

Table 12 – The use cases of applying city information modelling in urban underground pipeline management based on data lake

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-UPM-01	Making plan for pipeline system	To know the current distribution of pipelines and make rational planning scheme	This use case describes how the pipeline design supervisors of the municipal commission of urban management department use CIM to examine the current distribution of pipelines and make rational planning scheme. This helps them to make plan for pipeline system maintenance and development.	Pipeline design supervisor, data storage facility, CIM platform, sensing equipment
CIM-UC-UPM-02	Making plan for pipeline construction and reconstruc-tion	To make construction plan synchronized with other engineering construction plans, such as under-ground space, road traffic, civil air defence and subway, and to avoid "road zippers"	This use case describes how the pipeline design supervisors of the municipal commission of urban management department use CIM to make a plan for pipeline construction and reconstruction. "Road zippers" not only affect the appearance of the city and people's life, but also easily cause road collapse and pipeline accidents. This use case describes how pipeline construction supervisor makes synchronized construction plan with other engineering, such as underground space, road traffic, civil air defence and subway, to avoid "road zippers".	Pipeline design supervisor, data storage facility, CIM platform, sensing equipment

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-UPM-03	Supervising pipeline operation	To ensure the safe operation of pipeline	This use case describes how the pipeline design supervisors of the municipal commission of urban management department use CIM to ensure the safe operation of pipeline.	Pipeline design supervisor, data storage facility, CIM platform, sensing equipment
CIM-UC-UPM-04	Carrying out pipeline construction	To get permission from municipal commission of urban management	This use case describes how the pipeline design scheme is determined.	Pipeline construction manager, data storage facility, CIM platform, sensing equipment
CIM-UC-UPM-05	Implementing pipeline patrol	To make pipeline patrol more efficient and accurate	This use case describes how pipeline patrol is more efficient and accurate.	Pipeline operation manager, data storage facility, CIM platform, sensing equipment
CIM-UC-UPM-06	Implementing hidden danger investigation	To find the potential safety hazards	This use case describes how the pipeline safety manager of the pipeline construction and operation company uses CIM to implement pipeline hidden danger investigation. Pipeline safety is closely related to people's lives and property. This use case describes how the hidden danger is predicted.	Pipeline safety manager, data storage facility, CIM platform, sensing equipment
CIM-UC-UPM-07	Implementing lifecycle management	To access the data for later use	This use case describes how pipeline lifecycle management is achieved. It will promote digital transformation of pipeline operation and maintenance.	Pipeline lifecycle manager, data storage facility, CIM platform, sensing equipment
CIM-UC-UPM-08	Dealing with pipeline accidents	To take immediate action and minimize the damage and loss of emergency event	This use case describes how to quickly and accurately determine accident location and find the cause when there is a pipeline accident.	Pipeline accident manager, data storage facility, CIM platform, sensing equipment
CIM-UC-UPM-09	Dealing with pipeline accident	To take immediate action and minimize the damage and loss of emergency event	This use case describes how to quickly and accurately determine accident location and find the cause when there is a pipeline accident.	Pipeline accident manager, data storage facility, CIM platform, sensing equipment
CIM-UC-UPM-10	Implementing engineering construction	To know the distribution of the pipelines and avoid damaging the pipelines.	This use case describes how to avoid damaging the pipeline when engineering construction is implemented, such as subway, road, civil air defence.	Civil engineering construction manager, data storage facility, CIM platform, sensing equipment
CIM-UC-UPM-11	Reconstructing the pipeline for daily life	To avoid damaging the pipelines and avoid causing trouble to the neighbours	This use case describes how the citizen avoids damaging the pipelines and avoids causing trouble to the neighbours when they reconstruct the pipeline for daily life.	Citizen, data lake, CIM platform, data storage facility, CIM platform, sensing equipment, CIM online platform, CIM platform web server
CIM-UC-UPM-12	Finding actions endangering pipeline safety	To protect the pipeline	This use case describes how to protect the pipeline as a citizen.	Citizen, data lake, CIM platform, data storage facility, CIM platform, sensing equipment, CIM online platform, CIM platform web server

5.13.2 Use case analysis

The application of city information modelling (CIM) to urban underground pipeline management based on data lake aims to: a) integrate the basic information, maintenance information, health information and other data of pipeline on one platform to get the whole planning of pipelines; b) monitor pipeline operation in real-time, visually and intuitively; c) predict hidden danger; d) facilitate information exchange and sharing among different departments and build a cross-departmental collaborative mechanism.

The stakeholders of applying CIM to the urban underground pipeline management based on data lake include municipal commission of urban management (primary beneficiary, designer, owner and user), pipeline construction and operation company (secondary beneficiary and user), engineering construction company (secondary beneficiary and user), citizens (tertiary beneficiary and user).

CIM serves as a giant data hub, central processing unit and 3D visualization platform in city management. Firstly, the CIM can assist in creating three-dimensional pipeline model based on modern surveying and mapping, GIS, BIM, 3D modelling and other technologies. Secondly, CIM integrates basic and maintenance data for pipeline lifecycle management. Thirdly, CIM simulates, analyses and displays the pipeline operation state visually and intuitively.

Twelve city information modelling use cases were collected in the application area of urban underground pipeline management based on data lake regarding the stakeholders of municipal commission of urban management (3 use cases), pipeline construction and operation company (6 use cases), engineering construction company (1 use case) and citizens (2 use cases) (Figure 25).

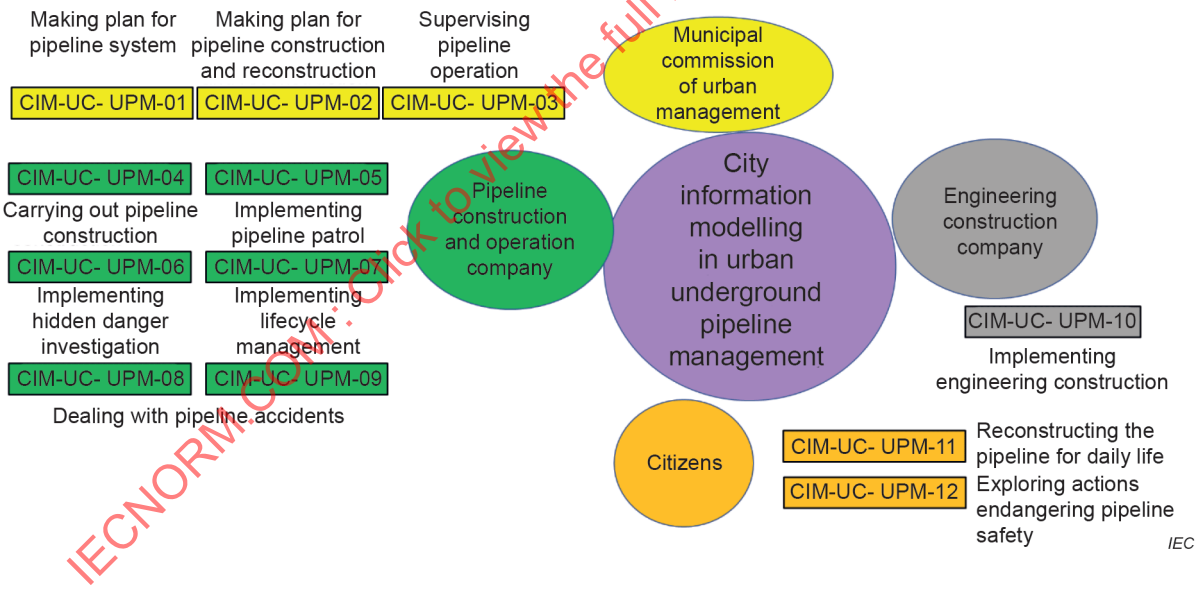


Figure 25 – Structure of use case of applying city information modelling in urban underground pipeline management based on data lake regarding stakeholders

The user stories and use cases serve different needs of applying city information modelling to urban underground pipeline management based on data lake (Figure 26): a) Different types of pipeline information need to be stored and accessed in one platform (CIM-NS-UPM-01, 4 use cases) ;b) information needs to be exchanged and shared among different departments (CIM-NS-UPM-02, 5 use cases); c) pipeline operation needs to be monitored in real time, visually and intuitively (CIM-NS-UPM-03, 1 use case); d) pipeline operation needs to be simulated, analysed and predicted (CIM-NS-UPM-04, 2 use cases).

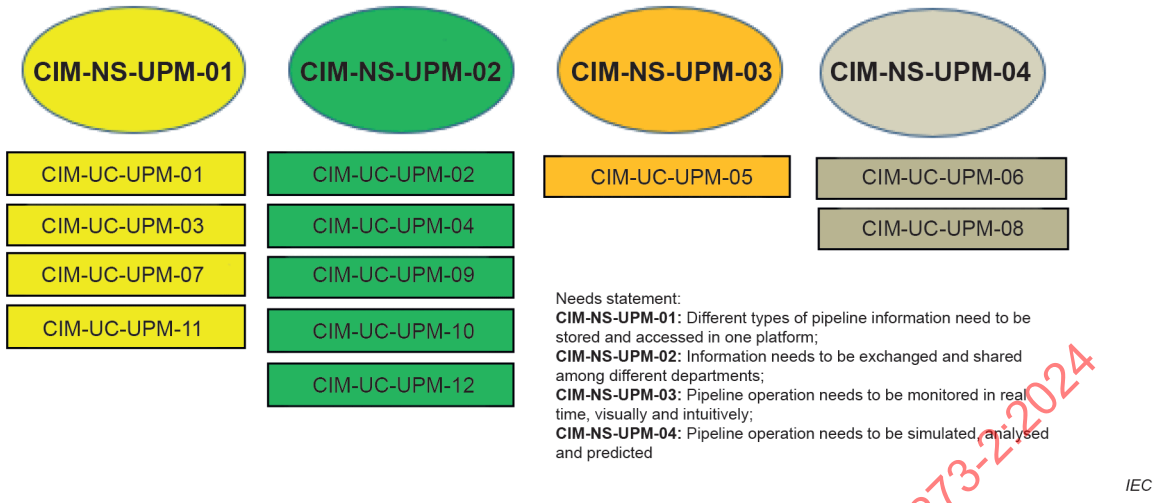


Figure 26 – Structure of use case of applying city information modelling in urban underground pipeline management based on data lake regarding needs statement

5.13.3 Requirements for the standards

- Basic data specification of city information modelling platform
- Technical specification for urban underground pipeline information management system

5.13.4 Related documents

Relevant standards of applying city information modelling to urban underground pipeline management based on data lake include:

- ISO 37166:2022, Smart community infrastructures – Urban data integration framework for smart city planning (SCP)
- Technical guidelines for city information modelling (CIM) basic platform (China)
- GB/T 29806-2013, Information technology – Technical requirements for exchanging underground pipeline data (China)
- 20181662-T-466, Data dictionary for underground pipeline features (China)

Standards need to be developed:

- Basic data specification of city information modelling platform
- Technical specification for urban underground pipeline information management system

5.14 Emergency management and rescue

5.14.1 Use cases

See Table 13.

Table 13 – The use cases of applying city information modelling in emergency management and rescue

ID of UC	Name of UC	Scope/ objective	Narrative	Actors (human and non-human)
CIM-UC-EMR-01	Upload inspection data	Provide platform channels for inspect officers to upload patrol data	This use case describes how onsite inspect officers use the CIM platform to perform on-site inspection. CIM platform provides an interface for on-site inspect officers to upload inspection data.	Inspect officer, commanders, business owner, data storage facility, CIM platform, CIM online platform, CIM platform web server
CIM-UC-EMR-02	Upload videos, pictures and other data in the early stage of fire, and receive emergency rescue plans	Provide an interface for emergency response officers to upload initial emergency data and a channel for receiving emergency rescue plan	This use case describes how emergency response officers use the CIM platform to feedback the initial disaster situation, to receive the emergency rescue plan, and to implement rescue operations.	Emergency response officer, commanders, business owner, data storage facility, CIM platform, CIM online platform, CIM platform web server
CIM-UC-EMR-03	Command dispatch	Dispatch emergency rescue team and equipment at the scene of emergency rescue	This case describes how the commander uses the CIM platform for command scheduling. The CIM platform integrates emergency rescue scene video surveillance, security point deployment data, and point operating status data to meet commanders' command and scheduling requirements.	Commander, emergency rescue team, business owner, facility, CIM platform, CIM online platform, CIM platform web server
CIM-UC-EMR-04	Simple and easy-to-use CIM platform	Help the CIM platform become easy-to-use	This use case describes the skills required to use the CIM platform. The CIM platform needs to be used by different types of stakeholders who possibly do not have programming, modelling, and simulation skills. The CIM platform needs to provide a friendly, unskilled interface for all types of users.	Emergency rescue team, business owner, data storage facilities, CIM platform, CIM online platform, CIM platform web server
CIM-UC-EMR-05	Data aggregation and analysis	Assist specialists to make decisions with the on-site date of emergency site inspection and initial disaster situation.	This use case describes the use of CIM platform by specialists in emergency management and rescue to understand the on-site inspection of emergency rescue and initial disaster information, and to formulate corresponding emergency rescue plans based on the on-site situation. The CIM platform aggregates field data to help specialists make decisions.	Emergency management and rescue specialist, business owner, data storage facilities, CIM platform, CIM online platform, CIM platform web server
CIM-UC-EMR-06	A large number of data exchanged	Exchange of emergency rescue data in multiple formats	This use case describes how business owners help emergency response officers to upload different types of data and how they can access the data through the CIM platform. The planning of the new emergency rescue area requires the collection of data from multiple stakeholders. Different stakeholders can upload their own data to the CIM platform as required. Business owners can access the data with permission.	Business owner, emergency response officers, data storage facilities, CIM platform, CIM online platform, CIM platform web server