Brussels' Digital Twin

Action Plan 2025

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0.1	04/02/2025	Catalin Turlica
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1.0		Final version to be released

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Brussels' Digital Twin Action Plan

City: *City of Brussels*

Challenge: *Mitigation of the Urban Heat Island effect in the City of Brussels*

Executive summary

a. **Overview**:
The Action Plan aims to identify and address the effects of the urban heat islands in the City of Brussels' districts through the means of a local digital twin. This involves creating a real-time model to simulate heat distribution patterns and spatial distribution of high temperatures. The model will help city planners and decision-makers in the city council, through its Climate, Urban Planning and Green and Public spaces units, understand and manage urban heat islands as well as their public health and environmental impact more effectively.

b. **Objectives**:

The primary goal of the Action Plan is to lay out and clarify the actions needed to set up the Local Digital Twin of the City of Brussels and its first use case on Urban Heat Islands. By focusing on the Urban Heat Islands' effects, the City aims to reduce the extent and the number of UHIs in the long term and to instore more freshness areas. This will contribute to a more habitable, healthier and more sustainable urban environment in the City of Brussels.

c. **Key stakeholders**:

- City departments and agencies:
    - **Smart City Unit:** as coordinator of the Smart City strategy and its flagship projects, oversees the development and implementation of the digital twin. Will be leading this project and will keep the different involved departments informed about the project.
    - **Data Unit:** ensures data governance and integrates relevant data into the digital twin.
    - **Climate Unit**: as coordinator of the Climate Plan of the city, monitors extreme climate events and temperature levels, oversees adaptation plans, will be one of the primary users of the digital twin.
    - **Public and Green Spaces Unit**: monitors and maintains public and green areas, will be one of the users of the digital twin to adapt their

interventions based on UHI effects, will integrate public and green spaces data to it.
    - **Cartography Unit**: will be one of the main contributors to the digital twin, and will also integrate up-to-date urban and GIS data to it.
    - **Urban Development Unit**: will be one of the users of the digital twin to adapt urban plans to UHI effects, and will integrate urban planning data to it.
    - **IT department (i-CITY)**: in charge of the development of the digital twin and its building blocks (following strategic guidelines from the Smart City unit), ensures data and system interoperability.
    - **City leadership**: the deputy mayors for City Planning and Climate will be making the final decisions on the urban design, type of vegetation, materials to be used, etc. based on recommendations from the departments/city steering committee that are based on the insights produced by the digital twin.

- External stakeholders:
    - The City of Brussels has established a Local Stakeholders Group for its digital twin (in the context of the Twin4Resilience INTERREG project), with the following members:
        - **Paradigm**: regional IT administration, owns part of the 3D data, as it is the authentic source for Building Data. Its mission therefore includes establishing regional models and standards (e.g. for a digital twin), training regional staff (e.g. on how to use a digital twin), carrying out IT and mapping projects (such as the Region's digital twin PoCs). Will be involved to ensure the regional interoperability of the City's digital twin.
        - **FARI**: research institute which aims to enable, promote and perform cross-disciplinary research on Artificial Intelligence in Brussels, inspired by the humanistic values of freedom, equality and solidarity that lay at the foundations of both the Vrije Universiteit Brussel (VUB) and the Université libre de Bruxelles (ULB).
        - **Brussels Environment**: regional environmental agency, provides data and expertise in environment data analysis and modelling. Brussels Environment is responsible for designing and implementing regional policies in all matters related to the environment.
        - **WeTechCare:** provides expertise in digital inclusion so that technology such as a LDT becomes an essential tool for improving the situation of vulnerable people. The aim is to open up digital opportunities to everyone and to improve social support through technology based on the insights produced by the digital twin.
        - **Democratic Society:** provides expertise in creating open and welcoming environments for participation, that aims at bringing people together and letting them take part in the

decisions that shape their lives and communities. Partner of the Twin4Resilience project.

- **Brussels City residents and local businesses:** beneficiaries of improved living conditions and air quality (potentially also informed about the Urban Heat island risk and most of all about locations of freshness islands and the most appropriate itinerary in case of a heatwave alert – tbc).

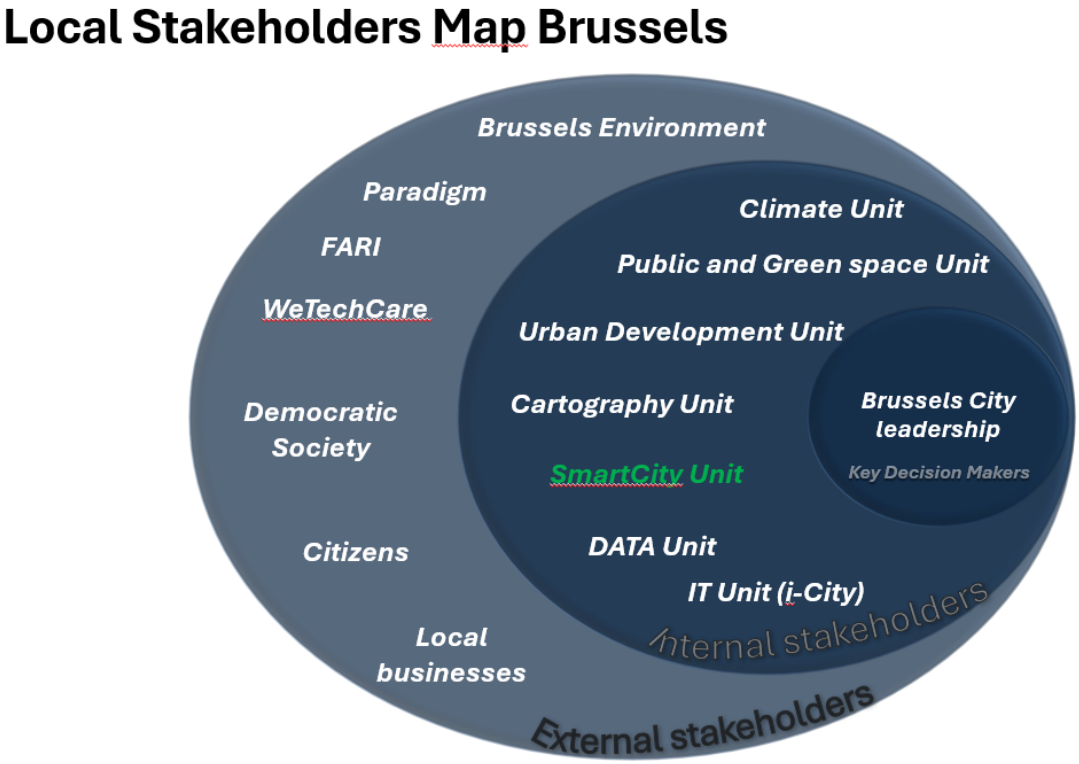

Figure 1 : Local Stakeholders map in Brussels (source : T4R project).

1. City information

Provide basic information about the city:

- **Number of inhabitants**: 196 828 (in January 2024, source: IBSA.brussels)
- **Size of the municipal budget**: €1.1 billion annually
- **Main city challenges**: Tackling urban heat islands is one of the key challenges of the City of Brussels' Climate Plan. The City of Brussels faces significant challenges due to urban heat islands, particularly in the City Centre Districts. Measurements taken in 2022 showed temperature differences of up to 9°C between dense urban areas and the reference station (RMI, Uccle) at 11pm, illustrating the difficulty of cooling the city

at night. Climate change will make heatwaves longer, more intense and more frequent, making city resilience essential. The high temperatures during the summer nights cause not only discomfort due to heat waves, but can also cause an increase in heat strokes leading to heat-related illnesses or amplify other preexisting conditions. It may also contribute to the persistence of elevated levels of traffic pollution, which pose several health risks to residents, and even increase energy costs (e.g. for air-conditioning)

- **Overall role of digital twin in the city's strategy**: In the long term, the City's digital twin will be a transversal tool, integrating different use cases from different policy domains, ideally with data cross-referencing. It will therefore be an integral part of the City of Brussels' strategy to enhance urban planning, sustainability and quality of life. The first use case of the digital twin, focused on UHIs, will allow building the basic blocks of the tool. By providing real-time data and predictive analytics, the digital twin will enable city officials to optimise freshness urban spaces distribution, environmental management and implement effective high temperature control measures. This initiative aligns with the city's broader goals of reducing carbon emissions, improving public health, and promoting sustainable urban planning.

2. A vision for the digital twin

The City of Brussels aims to develop a digital twin, as a transversal and evidence-based decision support tool. The ambition is to first develop a predictive digital twin, cross-referencing (near) real-time data from different policy domains to run scenario analyses. With sensors and static data, the City aims to improve its understanding of the UHI effects and evaluate the potential impacts of mitigation measures (e.g. white painting on roofs, vegetation, etc.). In this way, measures will be prioritized based on available budget and expected impact, and investment efficiency will be improved.

The initial developments of the digital twin targeted in this action plan will serve as a common basis for future extensions to the tool, in order to make it a truly cross-disciplinary platform. In the longer term, the City aims to continue developing its digital twin to make it capable of understanding and dealing with the complexities of urban reality, and interacting with objects in the public space or with other digital twins. A flexible architecture capable of supporting these developments (new use cases, new data sets and models, new functionalities) is required.

For the City of Brussels, the digital twin is not just a technological project, but also a strategic and political initiative. The aim is to create a dynamic model capable of evolving with the needs of the city, a predictive model that helps to anticipate future challenges. It also plays a valuable and important social role for the city, serving and federating not only the administration, but all sections of society, researchers, students, decision-makers, the private sector and, more broadly, all citizens.

The City of Brussels also wishes this project to be able to be extended to the regional level, in order to benefit from new data cross-referencing for new analyses, to understand the phenomena being studied (e.g. UHI) on a wider scale in order to enable joint and more effective responses. The City also aims to exchange analysis reports, simulations or prediction models with other regional players to improve efficiency, and allow for a better urban management at the scale of the Region of Brussels. As a pioneering municipality in the digital transformation of the Brussels region, and in collaboration with

Paradigm, the City wishes to share its experience (both positive as well as lessons learned) with the other administrations in the region, to provide them the interoperable digital twin model that it will develop and to enable them to benefit from the interconnections established within European initiatives and projects. In particular, through its participation in the INTERREG NWE (North West Europe) Twin4Resilience project, the city will have access to guides and training materials, which it can make available to players in the Brussels' ecosystem.

Additionally, as a member of several smart cities networks (e.g. Living-in.EU, OASC, etc.), the City of Brussels has committed to work on the interoperability of its digital systems (including its digital twin), on the levels of data, analyses or user experience.

In particular, for its first use case on UHIs, the City of Brussels' digital twin aims to address the effects and challenges of urban heat islands in the City's most densely and populated Districts. By leveraging real-time sensor data (mainly weather data), different landcover simulations and predictive analytics, the digital twin will optimise freshness urban spaces distribution and environmental management, providing at the same time a monitoring dashboard and a useful tool to enhance city planning. This initiative offers an opportunity to improve the quality of life for residents by reducing the urban heat islands' effects and by improving air quality. It will also have a positive impact on urban biodiversity.

The digital twin will support the City of Brussels' policy goals of enhancing sustainability, improving public health, quality of life and increasing urban efficiency. It will involve evidence-based policy-making and strategic planning, aligning with broader objectives to create a more liveable and sustainable urban environment. The primary users of the digital twin will be the Climate Department, the Public and Green Spaces, the Cartography and Urban Planning Units, who will use the system to monitor high temperature distribution patterns, evaluate and adapt urban design projects, track urban heat islands and temperature levels in real-time, and simulate the effects of policy interventions (e.g. new green areas, albedo adaptations, water fountains and moisturizers, etc.) before actually implementing them.

The UHI digital twin project aims at transforming town planning policy-making by providing city officials with a comprehensive view of urban dynamics and the possibility to assess public works interventions' impact as well as urban design projects impact well before implementing them. For example, it will simulate the impact of proposed urban areas redesign, such as new green areas, a change of the materials used to renew a square, planting of new trees, etc. on the ambient temperatures in previously identified urban heat islands. This allows policymakers to predict outcomes and optimise mitigation strategies before implementation of the aforementioned projects.

Brussels' City Digital Twin could also facilitate scenario planning, enabling the city to prepare for emergencies, such as extreme heatwaves or other natural catastrophes, pollution spikes and so on, by testing various response strategies. Additionally, by integrating data from multiple authentic sources and IoT sensors, the digital twin will help identify correlations and causal relationships, supporting more effective and targeted policy interventions.

3. Project objectives

a. Problem description

The City of Brussels suffers from elevated temperatures in some of its central densely populated areas, measurements taken in 2022 showed temperature differences of up to 9°C between dense urban areas and the reference station at 11pm, illustrating the difficulty of cooling the city at night. Moreover, figures from the Flemish Environment Agency indicate that the highest temperatures in the city during heatwaves are even higher in Brussels than in several other Belgian cities.

These issues cause significant discomfort, increase the risk of heat strokes or respiratory illnesses among vulnerable residents, and negatively impact the overall quality of life.

This problem is relevant to the City of Brussels as it affects both public health and public space use, making it essential to find sustainable solutions. Tackling urban heat islands is therefore one of the key challenges of the City of Brussels' Climate Plan. This Plan recommends using nature as a solution for mitigating UHI effects, however the city agents have a limited knowledge of the adequate measures to be implemented and no dedicated evidence based tool to support their decisions.

b. Expected output

The digital twin is expected to:

- Map accurately the UHI effect on the whole territory of the City based on different indicators (e.g. temperature, wind speed, or composite indicators), with an adequate level of detail that allows a precise understanding of the phenomenon and its impacts on urban spaces and population;
- Carry out in-depth analyses to support decision-making processes, such as simulations, scenario analyses, predictions;
- Model in 2D or 3D the results of these analyses.
- Simulate and measure the impact of the mitigation solutions envisaged;
- If technically feasible within the available budget, produce an easily understandable interface for communication and awareness raising towards citizens.

These outputs will enable city planners to implement more effective urban design, optimise public and green areas available, and design better urban infrastructure, thereby directly addressing the identified problems of urban heat islands and pollution.
The long term objective is to ensure the achievement of the use case's initial results, at a city wide level and overall target the reduction of Urban heat islands clusters and pollution levels. In accordance with the Climate Plan objectives, it is envisaged to reduce UHI temperatures by 30% and decrease emissions of NO2 and PM2.5 by 55% in the Downtown Districts over the next five years.

c. Target audience

The primary users of the digital twin will be :

- the Climate Unit: to monitor relevant indicators for the City's Climate Plan, oversee climate adaptation plans and assess the resilience of the City's territory.
- the Public and Green Spaces Unit: to assess the level of adaptation of the public and green spaces to UHI and adapt their interventions based on the digital twin's outputs.
- the Cartography Unit: to ensure coherence between the GIS data and maps and the digital twin. A feedback loop is to be explored, that would allow updating / improving GIS data based on DT simulations.
- the Urban Planning Unit: to assess the level of adaptation of the large urban projects and to adapt urban plans to tackle UHI effects. Test the feasibility of the suggested mitigation measures.

Both operational city agents and decision makers (from the administration and the political cabinets) will have access to the digital twin to make evidence-based decisions.

Depending on the technical feasibility and available funding, a light version of the Digital Twin could, in accordance with GDPR regulations, be also open to the public through a visualization platform.

d. Data required and owners

For the UHI use case of the digital twin, the collected data will be non-sensitive (not concerning individuals). All collected data will be interoperable and will comply with the City's data governance policy.

Below a preliminary list of data to be collected:

Air temperature
Physiological Equivalent Temperature (PET)
Humidity
Wind speed and direction
Precipitation
Solar radiation
UV radiation
Sunshine (average duration of sunshine on geolocations)
Urban form
Soil permeability
Vegetation (tree, high/low vegetation)
Albedo (reflection of solar radiation)
Effusivity (ability to absorb or release heat)
Thermal capacity / material temperature (night, day)
Air quality

TBD…

Figure 2 : List of Urban Heat Island (UHI) data to be collected

This list will be refined in the coming months (through a study conducted by external experts).

Data will come from different sources:

- Locally installed sensors (to be installed by the City);
- Climate and meteorological data (e.g. from the Royal Meteorological Institute of Belgium);
- Publicly available environment data from the Regional Environment Agency;
- Publicly available urban data from the Regional IT and Urban planning Agencies;
- Internal urban planning databases.

As stated, some crucial temperature data might be sourced from existing weather monitoring stations installed by the Royal Meteorological Institute. Therefore, a data-sharing agreement and protocol will most probably need to be established with the Royal Meteorological Institute to ensure access to this important data. The Climate and Data Units will closely collaborate with the Royal Meteorological Institute to ensure data accuracy and availability, as well as to seek usage and analysis guidance. Following the same approach, air quality as well as specific landcover data will be acquired from the Regional Environment Agency trough a data-sharing agreement and protocol that is to be set up in place once the user needs have been agreed upon.

e. Digital twin governance

The development and management of the digital twin will be overseen by the City of Brussels' Smart City Unit, which will make sure the long term vision is respected, the business needs are taken into account, the development planning is respected, etc. The Data Unit will lead the integration of collected data, in close collaboration with the Climate, the Public and Green Spaces, the Cartography and Urban Planning Units. Close collaboration with i-City (IT Department) will be crucial for the successful implementation of the digital twin.

A Digital Twin Steering Committee, including i-City, the Smart City unit, the Data unit and the relevant operational units will be set up to facilitate regular coordination meetings that ensure alignment and delivery of goals by all stakeholders. This Digital Twin Steering Committee will report to the Steering Committee of the City and the College of Mayor and Aldermen.

A collaboration relationship has already been established between the Smart City Unit, the Data Unit and i-City to coordinate the ongoing development of the crucial data building blocks of the digital twin. Regular meetings are planned to ensure and follow up progress.

f. Funding.

The total estimated cost for developing all components (including system and DT architecture, the 1st use case, other relevant use cases within domains such as mobility, energy, environment, etc.) of the digital twin is 3.4M€. Potential funding sources include the municipal budget, grants from the European Union (INTERREG subsidy for the ongoing Twin4Resilience

project – 396 900€) and partnerships with private sector stakeholders. I-CITY will plan the budgets needed for the IT developments and launch the necessary procurements. The City of Brussels's Smart City Unit will complement funds from the municipal budget by applying for relevant grants or negotiating partnerships.

g. Other stakeholders involved

- *City departments and agencies:*
  - ***Smart City Unit:*** *as coordinator of the Smart City strategy and its flagship projects, oversees the development and implementation of the digital twin. Will be leading this project and will keep the different involved departments informed about the project.*
  - ***Data Unit:*** *ensures data governance and integrates relevant data into the digital twin.*
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- ***Brussels Environment*** *: regional environmental agency, provides data and expertise in environment data analysis and modelling. Brussels Environment is responsible for designing and implementing regional policies in all matters related to the environment.*
- ***WeTechCare :*** *provides expertise in digital inclusion so that technology such as a LDT becomes an essential tool for improving the situation of vulnerable people. The aim is to open up digital opportunities to everyone and to improve social support through technology based on the insights produced by the digital twin.*
- ***Democratic Society:*** *provides expertise in creating open and welcoming environments for participation, that aims at bringing people together and letting them take part in the decisions that shape their lives and communities. Partner of the Twin4Resilience project.*
- ***Brussels City residents and local businesses:*** *beneficiaries of improved living conditions and air quality (potentially also informed about freshness islands – tbc).*

4. Diagnosis: bottlenecks and obstacles

a. Vision

Given that the Digital Twin is a relatively new concept, without a doubt, our departments still have different understandings of the digital twin's potential. The Climate Unit views it as a tool to identify the locations and reduce the effects of the urban heat islands, while the Public and Green Spaces Unit focuses on monitoring vegetation only. The Cartography and Urban Planning Units see it as a simulation and visualization tool. The Smart City and the Data Units see it as an opportunity to enhance data integration and smart city initiatives, through both internal departments' closer collaboration and citizen participation.

On the other hand, i-City views it as an opportunity to create a shared and interoperable IT architecture that can be reused by other departments.

There is a need for raising more awareness in most of the City's departments, especially for the potential users of the LDT. Focused on their core expertise tasks, many don't know yet what a LDT is. Workshops and training programs are being developed via the City's participation in the Twin4Resilience project.

The local political situation adds yet an extra layer of nuance : a new political majority has been installed at the end of last year, with possibly other strategical views on the innovation and technological scene. The Smart City Unit will therefore try to integrate and defend the digital twin as a flagship project of the political agreement.

These varying perspectives often create a challenge in aligning our goals and ensuring all departments are on the same page. The City is are aware that to overcome this it requires both internal and external structured workshops in order to unify our vision and demonstrate the comprehensive benefits of the digital twin. The Smart City Unit is constantly working on aligning the views on the matter and ensuring that all business requirements are taken into account in the future Brussels' Digital Twin.

b. Digital twin governance

Establishing a robust governance framework with regular coordination meetings and clear decision-making protocols is essential. This step has been recently fulfilled and the City is currently looking into solutions and best practices on how to implement this. Additionally, aligning our internal resources with those of i-City, the IT and technology provider of the city, requires thorough planning and cooperation.

The City still faces a challenge in implementing the roles and responsibilities as defined in the Governance Plan for the digital twin project.

Nevertheless, administration silos and potential lack of inter-departmental communication might still sometimes be hindering progress.

So far, it has been determined that the Digital Twin Steering Committee, including relevant departments, will be responsible for Digital twin related decision making (The Climate Unit will lead on climate & weather data, air quality and pollution data, the Public and Green Spaces Unit will focus on monitoring vegetation, Urban development will lead on urban design mitigation measures, the Data Unit will focus on data integration). The Smart City unit is responsible for the global strategic vision for the LDT and the coordination with other operational departments.
i-City will guarantee the technological coherence of the project and its integration within the City's IT architecture (in coordination with the Smart City and Data units).
The coordination mechanisms will most likely be refined, in an agile framework, as the project progresses, to gain in efficiency.

- Political leadership

Securing strong political support is challenging, nevertheless critical. The digital twin project was part of the political majority agreement for 2018-2024. At that time, the Deputy Mayor for Economic Affairs, Employment, Smart City and Administrative Simplification at the City of Brussels recognised the potential of Digital Twins to improve urban management and considered it an important and strategic asset. The current Deputy Mayor of Civil Status, Citizens' Affairs, Seniors, Information and

Communication Technology, the Vehicle Fleet and Purchasing and Facilities shares this vision but still needs to get acquainted with this technology and to grasp its various opportunities for the City. The political majority agreement for 2024-2030 still includes the Digital Twin as an important project and a means to make the City smarter and to improve citizen's quality of life.

Continuous engagement with the other new political leaders, in particular with the Deputy Mayor for Urban renewal and Climate and the Deputy Mayor for Town Planning and Public Spaces, showcasing short-term wins, and aligning the project with broader political agendas are necessary to maintain commitment and support.

- Internal alignment

Due to the transversality of the project, ensuring that all relevant departments are engaged and working together is somewhat challenging. The Climate Department, Public and Green Spaces Department, Urban Department and the Environmental Agency could potentially sometimes have different priorities, with some focused on urban renovation and development and the other on environmental aspects, which is understandable given their respective expertise and responsibilities. These discordant visions, though taken into account through our governance scheme, could potentially hinder our progress and impose realignment. Facilitating inter-departmental cooperation at early stages of the project involves creating a unified vision, setting shared goals, and providing resources for joint initiatives. A clear political direction, would also facilitate things. In general, regularly organized workshops and cross-departmental exchange sessions will help foster a collaborative environment. Moreover, clarifying roles and responsibilities through detailed official documentation and structured communication channels is essential to prevent misunderstandings and overlaps.

- External partnerships

The city lacks the internal capacity to fully develop the digital twin on its own and relies on support from i-City and, to a lesser extent FARI (FARI – AI for the Common Good Institute and its research group) and Paradigm via our Local Stakeholders Group (LSG) in the context of the Twin4Resilience Interreg NWE project. i-City focuses on delivering a technically sound architecture but its implementation views / interests may not always align fully with our operational views or budget constraints. FARI could provide research support but may prioritise theoretical research over practical solutions, potentially misaligning with our Digital Twins project needs. Constant external stakeholders realignment might prove useful. Moreover, ensuring data ownership, overall interoperability and avoiding vendor lock-in are critical. Establishing clear agreements on data sharing, roles, and responsibilities, alongside regular communication and mutual accountability, will help align our goals and manage potential incoherences. The other LSG partners (from the T4R project) mentioned before will help the City at ad hoc moments when it seems most relevant for the project and its evolution.

- Embedment into policymaking process

Even though currently changing, there is a general lack of tradition in the City administration to use data-driven insights for policymaking. This approach could potentially hinder the effective use of digital twin insights. To integrate these insights, the Smart City unit became aware that there's a need to develop comprehensive training programmes for policymakers and establish streamlined processes in order to better incorporate data into decision-making. Such training programs are planned to be developed via the Twin4Resilience project that we are part of. On the operational level, certain ongoing initiatives aim at proving data value and utility in the decision making process. Demonstrating the effectiveness of data-driven approaches through Digital Twin pilot projects and fostering a culture of innovation within the administration will eventually contribute to overcome this barrier. The training scheme, focused on Digital Twins, foreseen through the City's participation in the Twin4Resilience Interreg North West Europe Program will amplify data-driven approaches initiating a genuine change in the management process.

c. Funding

Securing and sustaining sufficient funding for the € 3.4 mil digital twin project is challenging due to other competing budget priorities like housing and infrastructure maintenance.

To ensure budget allocation, strong political buy-in is essential. This requires making a compelling financial case by demonstrating cost savings and improved public health outcomes, and politically aligning the project with city priorities. Engaging political leaders, showcasing pilot successes, and aligning the initiative with the city's strategic vision are crucial.

Alternatively, collaborations with other public agencies, or regional authorities, or even local businesses might constitute a working lead (as they might invest in the project with certain data and technology-ownership conditions). Synergies on the regional level or with other cities will certainly help mutualize costs.

EU grants are also regularly considered for pilots and for the basic building blocks architecture, one example is the participation in the Twin4Resilience project.

d. Data

A major challenge is the availability of data. At this moment, the City of Brussels does not have all of the mentioned data available (except the data that could be acquired from the RMI and 3D regional data, ready to integrate), neither for visualization nor for analysis in the Digital Twin. There is a first draft list of the data that the city intends to use, to what purpose and priority, and how the city could obtain this data. The most essential and up-to-date data can be obtained by installing weather stations that are integrated with the Digital Twin. In the PoC of the T4R project, this approach will be tested on a limited geographical area. Other (important but not essential) data can normally be obtained via 3rd parties. Nevertheless, more

expert domain knowledge is required and public tenders are being prepared to address that need.

- Data infrastructure

As it regards our current data infrastructure, it is not yet fully capable of supporting the digital twin's requirements due to ongoing changes on the data storage capacity, the processing systems, and most of all on the data integration capabilities. i-City is currently working on setting up a Data Warehouse, with high-capacity servers, advanced data processing software, and enhanced network infrastructure to handle large volumes of (near) real-time data efficiently (that will be useful for other projects that share the IT infrastructure). Additionally, the City needs technical expertise to manage these upgrades and ensure seamless integration. Further collaboration with i-City will facilitate this process by providing cutting-edge technology solutions and expert knowledge in data infrastructure, ensuring the LDT systems are robust, modular and scalable. I-City will also guarantee that the Digital Twin and its architecture will be created in a modular way, that it can easily incorporate additional capabilities and use cases in its new infrastructure, ensuring long-term sustainability.

- Data ownership and governance

We need to ensure availability of and access to data required for the digital twin, and a part of it is in the regional agencies' or national institutes' ownership. Thus, our municipality must establish comprehensive agreements with the respective environmental institutions, which own the climate data, the air quality monitoring stations and mobile sensors, to ensure seamless data access. These agreements will include clear terms on data sharing, ownership rights, usage limitations, and responsibilities for data maintenance. An agreement about data exchange between the City and several regional partners is currently being drafted outside of the LDT project but will also be useful to facilitate diverse type of data exchanges on regular basis. Protocols need to ensure data integrity, interoperability and legal compliance by outlining standards for data accuracy, security measures, and privacy protections. All stakeholders, including city departments and external partners, will be bound by these protocols. The data governance framework implemented at the City's level includes representatives from the Smart City Unit, the Climate Unit, Public and Green Spaces Unit, the Urban Unit, the Data Unit, as well as i-City, the DPO and could / should be extended to legal advisors (and other relevant internal stakeholders). This framework defined (and is currently implementing) roles, responsibilities, and procedures for data management, ensuring consistent and lawful data handling practices.

- Regulations and legal considerations

Establishing a dedicated legal team to monitor compliance (with GDPR, the "Data Sovereignty Act" , AI Act, etc.) and address legal issues is a must. We are therefore engaging with our inhouse legal and IT experts as well as our DPO and consulting with regulatory bodies early in the project for them to help navigate these challenges and ensure smooth implementation. Ensuring compliance with the "Data Sovereignty Act", which mandates that all sensitive data collected within the city must be stored on

servers physically located within municipal boundaries could prove rather challenging. Nevertheless, The City does not intend to collect any type of sensitive data neither in the LDT PoC nor in the designated Use Case scenario. Therefore, the internal units have been setting up the necessary infrastructure and implemented the required measures. The integration with cloud-based services used by i-City is ensured through developed and robust data protection strategies, continuous checkups thorough legal reviews and implementation of secure data storage solutions. However, one reason of concern is the setting and installation of IoT sensors in the public spaces, as building and environment permits are/could be required. This might result in delays of implementation and a thorough preparation of mitigation solutions is required.

e. Procurement

The procurement process for the City of Brussels' digital twin project is fit for purpose and suited for cutting-edge technology acquisition, as the last tenders we have launched can certify. We are nevertheless trying to improve our process flows as much as possible, to ensure a good level of interoperability and take into account the need for innovation. Current evaluation criteria offer a balance between cost and innovation, ensuring selection of capable providers. In addition, procurement contracts are addressing data ownership and technology control, in order to ensure stability and clear operational responsibilities, and most of all anticipate for future IT architecture changes.

To respond to these specific challenges, our IT department (i-CITY) is in the process of launching a «stock» public tender on "Data and innovation" in order to anticipate and cover future needs related to the digital twin project. It has been decided that the clauses should include data and system interoperability and modularity requirements. Moreover an in depth study of our use case has been launched in the early stages of 2025, the results will be used as a solid basis for the IoT sensor tenders that we foresee.

5. Strategic actions and timeline

The strategic actions considered by the City of Brussels for the development of its LDT are meant to be procedural and incremental actions, beginning with foundational steps and progressing through to final implementation and evaluation stages. One important milestone worth mentioning upfront is that the City aims for an MVP of its Local Digital Twin by the end of 2026, as stated in its T4R project application plan.

a. Foundational steps

The foundational steps for developing the LDT for the City of Brussels involves several key actions.

First, local stakeholder engagement is essential; this includes identifying and involving city officials, urban planners, technology providers, and community members through workshops to gather their input on needs and concerns, as well as future use cases. Through the first stages of theTwin4Resilience project the Smart City Unit has been working on identifying the most relevant

stakeholders in its local ecosystem (see fig.1). They are now concentrating their efforts in regularly engaging them either via workshops or via one to one meetings.

Furthermore, an external consultant agency already helped the City to define more clearly which IT building blocks would be needed, the ones the City already had and the ones that would still need to be developed (with or without external help). This helped i-city to have a better view on the expectations the City expected from them for this project and address priorities (the visualisation platform for instance). It helped the City to create a more defined planning for this project.

It also enabled the Smart City Unit to draft a list of requirements to better guide i-City regarding the tools and platform expectations and requirements for development and maintenance. The study launched beginning of 2025 to help the City define the UHI use case will also provide new insights regarding these requirements that are needed in order for the IT team to develop an MVP.

The Smart City unit has been drafting objectives for the UHI use case while focusing on areas such as urban planning, public service enhancement, and resource optimization, ensuring alignment with city goals and sustainability targets. These will be discussed with the different involved departments during the workshops linked to this new UHI study. Moreover, an inventory and assessment of existing data sources, including urban form, land use and cover, transportation, microclimate and other relevant environmental data, is crucial. This helps identify gaps that need addressing for the UHI digital twin's effectiveness. Even if a necessary data list has already been drafted, these workshops will also enable to identify more clearly the essential data, how the City can get it, the ontology between data blocks (useful for the modelling later on), etc.

Based on this study, data and sensors will need to be acquired, installed and integrated in the City's data lake.

The algorithm and simulation model will then need to be defined via another study.

b. Implementation steps

Implementation stages will focus on data integration and management, which involves creating a strategy to consolidate data sources and by ensuring data accuracy, quality, security, and privacy. The digital twin model will be then developed, featuring 2D/3D visualizations and real-time data feeds, alongside simulation tools to accurately replicate UHI effects and mitigation solutions.

One pilot project will be initiated to focus on specific areas highly affected by the UHI effects and their impact on the surroundings, allowing for demonstration of the digital twin's capabilities and gathering feedback for improvements.

A first version of the LDT (the MVP) will be launched, in order to test the model, the interoperability, etc.

Lastly, fostering collaboration with technology and innovation firms, research institutions, and community organizations will be vital to share knowledge and ensure the digital twin meets public needs and accessibility concerns.

Based on the use case results and on the stakeholders feedback we plan to draft a strategy for the long-term maintenance and updating of the digital twin, ensuring it becomes futureproof and it remains relevant and effective.

The LDT will be upscaled (to a wider area in the City, to more use cases, to external use cases, etc.).

c. Detailed actions and foreseen implementation

The exact actions planned and their description are detailed in the table here after.

VILLE DE BRUXELLES
STAD BRUSSEL
CITY OF BRUSSELS

	Brussels action plan		Before T4R	Period 1 (M6) 2024						Period 2 (M12) 2024						Period 3 (M18) 2025						Period 4 (M24) 2025						Period 5 (M30) 2026						Period 6 (M36) 2026						
				January	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	June	July	August	September	October	November	December	Jan
#	Action	Description		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
1	Preliminary study on LDT	Conduct and coordinate a preliminary study on the IT infrastructure, available data and the Digital Twins' features best suited to be implemented for the City of Brussels.	2022																																			
2	Secure political buy-in and MVP funding (Smart City Strategy)	Present the digital twin project to the new political leaders *(following the local elections)* , highlighting its benefits such as reducing the effects of the urban heat islands and improving air quality. Apply for grants from the European Union , on a regular basis, establish public-private partnerships with local businesses, and allocate municipal funds.	2023																																			
3	2nd study on LDT	Conduct and coordinate a validation study on the Digital Twins' architecture, as well as the functionalities and the UHI use case validation.		M1					M6																													
4	Create Local Stakeholder Group (LSG)	Create an external ecosystem around the T4R LDT project: the local Brussels T4R local stakeholder group with FARI, Paradigm, BxI Environment, etc.		M1					M7																													
5	Develop a unified vision for the digital twin	Conduct workshops and meetings with all key municipal stakeholders, including the Climate Unit, the Green Works, the Cartography and Urban Planning Units, Environmental Agency and the Smart City Unit to develop a unified vision for the digital twin project fully integrated in the Smart City Strategy.	*2023 & 2024* workshops	M1		M3																																
6	*3rd study on LDT*	Conduct and coordinate a more in-depth study on the Digital Twins' necessary data and indicators for the UHI use case.										Launching of the public procurement for this study				M13					M18																		
7	Collect user requirements	Conduct workshops and meetings with all key municipal stakeholders in order to collect their needs for the UHI Digital Twin MVP														M13								M21														
8	Define further the IT architecture	Define / upgrade the requested IT architecture (based on the 2nd study) and ensure its maintenance and its interoperability with existing systems (GIS, 10 mins platform).														M13								M21														
9	Establish a LDT governance framework	Create a governance task force (Digital Twin Steering Committee): internal governance group comprising representatives Digital Twin Steering Committee with i-City, Smart City unit, Data unit, other relevant operational units depending on the use cases. Define roles, responsibilities, and decision-making protocols.														M13					M18																	
10	Determine change management strategy (CMS)	Determine change management strategy (CMS)														M13					M18																	
11	Determine communication strategy (CoS)	Determine communication strategy (CoS)														M13					M18																	
12	Develop the Modeling and Simulation strategy	Develop and deliver basic simulation scenarios allowing to test the the LDT's response to the user needs. Include alerts and notifications based on the agreed scénarios.																			M18										M29							

#	Action	Description	2024		Period 3 (M18) 2025					Period 4 (M24) 2025						Period 5 (M30) 2026						Period 6 (M36) 2026						Period 7 (M42) 2027						Period 8 (M48) 2027						Period 9 (M54) 2028					
			ovember	December	January	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	June
			11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
13	Develop User Interface	Develop and implement an intuitive interface for accessing data and insights, customizable and mobile-friendly / responsive. Integrate role-based access conrtrol for different user groups (e.g., city officials, researchers, citizens)								M18											M29																								
14	Develop algorithms	Develop (or acquire) the UHI algorithms. Provide clustered results (ideally also support real-time analysis).								M18											M29																								
15	Define KPI's	Define KPI's to ensure and adequate reponse to user needs and thay key objectives of the roadmap are met.			M13								M21																																
16	Enhance data governance	Set up a centralised data governance framework with clear policies for data management (Digital Twin Steering Committee), involving representatives from the from the Climate Unit, the Green Works, the Cartography and Urban Planning Units, Environmental Agency and the Smart City Unit, the Data Unit, i-City, and legal advisors. LDT project expert.									Specific to IHU LDT (M19 - M24)																																		
17	Train policy-makers	Develop and deliver training programmes for policymakers to utilise data-driven insights effectively. Include practical sessions on integrating digital twin outputs into decision-making processes.									WP3 dates (M19 - M42)																																						
18	Ensure interoperability	Coordinate with IT Department to ensure the interoperability between sensors and the systems (integrate reliable communication protocols (e.g., LoRaWAN, Zigbee))												M22																				M42												
19	Data & sensors acquisition	Acquire Data and/or sensors (buy weather stations and other IoT devices adapted to the UHI use case, install them on the study area, set up data streams) to feed the LDT analysis models. Ensure the security standards are met, as well as compliance with data protection regulations. Include the IoT sensors in the sensor registry of the city. Also ensure protocols are put in place regarding the data that is shared/collected from external sources (Paradigm, etc.). Also include citizen engagement (curieuzenair, sensors from ULB/VUB, etc.)												M22						M27																										
20	**Local Digital Twin MVP**	Implement the LDT in a MVP stage in the production environment. Collect end-users feedback and test extreme scenarios.																			M28						M36				M39														
21	Jointly develop T4R final pilot project deliverables + communication about the project	Jointly develop T4R final pilot project deliverables for peer review + communication about the project																											M37					M42												
22	**Scale up of the UHI LDT at City Level**	Implement the LDT in the production environment at City scale. Analyze City scale results and compare with the MVP for lessons learned.																																	M43											M54
23	Collect & integrate accessibility & citizen feedback	Collect & integrate accessibility as well as citizen feedback in the LDT by adapting key features accordingly. Enhance accessibility of the LDT and citizen experience (taking various profiles into account)																																				M46								M54

#	Action	Description	Period 5 (M30) 2026						Period 6 (M36) 2026						Period 7 (M42) 2027						Period 8 (M48) 2027						Period 9 (M54) 2028						Period 10 (M60) 2028						2029						2029	
			nuary	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	June	July	August	September	October
			25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70
23	Collect & integrate accessibility & citizen feedback	Collect & integrate accessibility as well as citizen feedback in the LDT by adapting key features accordingly. Enhance accessibility of the LDT and citizen experience (taking various profiles into account)																						M46						M54																
24	Refine & follow up strategy of LDT	Follow up of the KPI's, enhance functionalities and accessibility/ergonomy, etc.																						M46																					M69	
25	Train local and regional policy-makers	Accompany, develop and deliver training programmes for regional policymakers to utilise data-driven LDT insights effectively. For example, conducting workshops for local, regional administrations and other partners on using digital twin data to formulate sustainable urban and environmental policies on a regional level.																							M48										M58										
26	Functional / Regional scale up	Coordinate and develop new LDT functionalities and contribute to the regional LDT functional analysis and scale up. Assessment and gap analysis with existing tools and business model.																											M54					M58											
27	**Test the data & functionalities of the LDT**	Test the data & functionalities of the extended LDT. Asses the use case coherence with the scaleup.																																M58										M69	
28	Addapt the visualisation tool	Addapt the visualisation tool based on user feedback and include a customizable dashboard.																																M58										M69	
29	**Expand the LDT to new use cases**	Develop and integrate new use cases (Rooftops (Interreg), Buildwind (wind/air quality), accessible buildings, MyPermit BIM, etc.). Citizen engagement data (telraam, etc.)																																M58										M69	