Summary of the investment proposal

NATIONAL DIGITAL TWIN OF THE PHYSICAL LIVING ENVIRONMENT

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The Netherlands faces major social challenges that have far-reaching consequences for the design of our living environment. These challenges are related. We want to make our energy system more sustainable, for example, which will require changes to the energy infrastructure (1). The mobility system of highways and waterways is reaching capacity limits (2). A significant part of this infrastructure is in need of replacement, with effects on space, air quality, climate, traffic safety and the quality of life in cities. There is a need to build one million homes, for which locations must be determined (3). Agriculture and mobility require a transition, partly because of nitrogen emissions (4), and finally the climate is changing, so periods of extreme drought and precipitation, rising sea levels and salinization of the land must be taken into account (5).

In addition to their mutual interdependence, these tasks are characterized by urgency and time pressure. They are also complex and make an appeal to what is scarce in the Netherlands: physical space. To tackle these interrelated and complex issues, many parties are involved: governments, citizens, knowledge institutions and the business community.

Participation and information

This multitude of stakeholders and underlying complexity of issues requires intensive participation from all involved and needs a common information base. In order to arrive at open, honest and inclusive views, judgments and decisions, a precondition is that participation takes place on the basis of public values. Values that reflect our society so that the necessary societal support for transition or transformation is guaranteed in all phases. These are public values such as equality, freedom, human dignity, autonomy and safety.

The common information base needed for this, will be based on design principles that support and realize these public values. The design principles not only promote cooperation between the parties involved in the tasks but also guarantee the responsible use of technology and data necessary to realize the tasks.

Digital Twin

Various coalitions of governments, companies and knowledge institutions are already working with a common information base to deal with the complexity and interconnectedness of societal challenges. They use the instrument of the digital twin. The digital twin of the physical living environment (DTFL), refers to a digital representation of both urban and rural environments, in which scenarios can be created based on static and dynamic data, models and visualizations. The DTFL:

- Connects stakeholders around the social challenges;
- Helps to describe and visualize the data relevant to current and desired physical living environment by means of (3D) visualizations and clarifies the legal context with respect to possible policy and physical adjustments.
- Enables the consequences of interventions to be calculated, predicted and

simulated.

- Offers insight so that solutions and decisions can be reached more quickly.
- Supports managers in the efficient management and maintenance of physical objects through effective monitoring.

Technology

The technology of the DTFL is not new, but is now applied in a fragmented and isolated way. We also note that the involvement of citizens and civil society organizations could be improved. By creating rules for the use of the DTFL and forming coalitions around tasks in which citizens and social organizations participate, we foresee more synergy and support. In this way, acceleration and efficiency can be achieved.

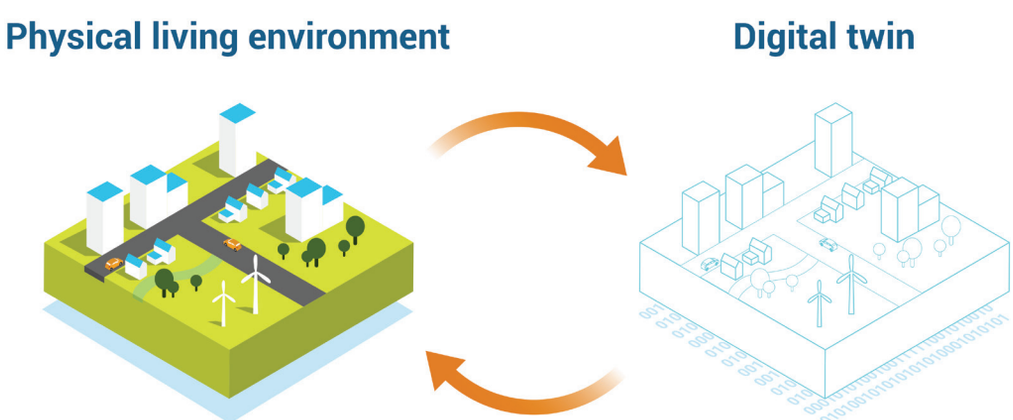

Figure 1: the digital twin of the physical living environment (DTFL)

National DTFL as a public instrument

Our dot on the horizon is a National DTFL - which provides a nationwide picture of the living environment in the Netherlands. This National DTFL is used as a public tool by governments, citizens, companies and knowledge institutions to explore societal challenges in the physical living environment and to design and develop solution scenarios.

This process of 'Digital Twinning' uses the insights of digital twins to arrive at supported decisions and to translate these into solutions which are monitored during their life cycle. Applying this technology and knowledge on a national scale with a public instrument, makes solutions smarter, faster and more social.

The National DTFL is not one system, but consists of a federated body of agreements around three components:

1. The sum of regional, thematic or urban DTFLs that have been developed for a social issue in the physical living environment. These DTFLs are connected to each other.

Developers of new DTFLs can use existing functionalities and enriched source data and models and build on them, knowing that ingredients come from a reliable DTFL Infrastructure. This way, the knowledge surrounding the assignments is shared as much as possible.

2. The DTFL infrastructure[1] enables sharing of source data, models and visualizations. The DTFL infrastructure provides access routes to all kinds of sources and application services and interfaces, thus ensuring reliable national access to the ingredients for a DTFL.

3. The practice of Digital Twinning is brought together in the DTFL ecosystem. The DTFL ecosystem provides the standards surrounding the development and use of a DTFL, such as a set of quality marks and instruments that ensure meaningful, predictable and transparent use within a context of public values. This is how responsible Digital Twinning becomes a reality on a national scale.

Public values

In line with the European agenda[2], we want to design a National DTFL for spatial challenges based on public values. This relates to the way in which both participation is organized within the nDTFL and those involved exercise influence. We translate these public values into design principles.

Part of these principles is Information security. For digital twins to be applicable, it is important that the original data sources, modifiers or enrichers are traceable (transparency, provenance) and that they have not been manipulated between creation and delivery (integrity).

These principles have an effect on all components in the DTFL infrastructure, and require a thorough understanding, because there are always trade-offs to be made so that, for example, transparency and integrity do not come at the expense of privacy or efficiency and effectiveness.

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[1] This digital twin infrastructure builds on the foundation of the Nationale Geo-Informatie Infrastructuur. It has been realized in the last 15 years in a planned way, rooted in the National Geoinformation Policy, instrumented with legislation (basic registrations, INSPIRE), structurally financed, implemented in government services and it's access has been assured for society through the National node Publieke Dienstverlening Op de Kaart.

[2] The European commission sees great value in digital transformation and use of data. With regulation, stimulation and financial resources, the commission aims to realize that value. In doing so, it has made the choice that public values must be central to the legal framework.

Targets

The program is realized by a consortium that endorses the value-driven approach and represents societal complexity. The focus is on four goals:

1. Fast, smart and widely supported realization of solutions for social challenges by using the digital twin as an instrument. To this end, ten Field Labs will be set up with tasks that are image-defining. 'Quadruple Helix' coalitions (government, citizens, companies and knowledge institutions) will work on solutions to these tasks using a DTFL.

2. Forming collaborations with other initiatives developing thematic DTFLs. We see private initiatives developing thematic DTFLs around mobility, the built environment and infrastructural works. These initiatives provide software and data and contribute knowledge through the use of calculation and simulation models. We are looking for commitment from these parties to include these DTFLs and the associated data and models ('dataspace') in the National DTFL.

3. Unlocking knowledge from private initiatives and field labs. The developed DTFLs are broken down into recipes consisting of the ingredients; data, calculation models and technology. We are developing a National DTFL infrastructure to unlock these according to rules and standards that we agree upon with the suppliers. In addition, success factors and best practices from both the development and use of DFTLs at the Field Labs and private initiatives, will be collected and incorporated into training and educational products.

4. Securing working with a digital twin in an ecosystem of users. Everything we develop will be secured in the National DTFL, a federated entity in which specific DTFLs are connected. To this end, we are looking for national partners who endorse the ambition and are capable of boosting the adoption of DTFLs in their sphere of influence. So that the DTFLs from the Field Labs and private initiatives are reused in a different context.

   In addition, it is essential that we train commissioners of societal challenges and their direct stakeholders in the development and use of the DTFL based on the foundation of public values. This requires community management so that the demand for good training, based on success stories from practice, arises.

Value creation

Simultaneously with development, we are learning to apply the digital twin to social issues in the physical environment with the coalitions of governments, citizens and businesses. As a result:

- We shape the cooperation between governments, citizens and businesses, in a new way, supported by the instrument of the DTFL.
- Participation and co-creation with the parties involved in a task in the physical living environment is given new meaning and content by working with the DTFL instrument.
- We will learn which alternative solutions are possible and from which ingredients they arise. Simulation and calculation within the DTFL provide us with these insights.
- We do efficient management and maintenance of physical objects by monitoring, collecting/processing and applying asset management principles.
- Do we form a DTFL infrastructure that houses these ingredients and makes them easily accessible?
- Are we able to multiply the knowledge gained around DTFLs and dataspaces and apply it elsewhere in the Netherlands and act as a guiding example in European developments?
- We create opportunities in Europe[3] for the business community and knowledge institutions to export the knowledge and software tools they have acquired, for example in the themes of healthy urban living, housing and energy transition, water management, climate adaptation and agricultural transition.

Efficiency

Digital Twinning (working with a DT using the National DTFL as a federated entity) is an innovation method for understanding issues and sharing knowledge about Digital Twins. In it, the National Digital Twin provides for the stacking of knowledge and application. These insights accelerate the solution process and reduce costs.

Digital Twinning improves the transparency of the image, judgement and decision-making process of the spatial interventions that are related to solving the societal challenges. In addition, the insights reduce the size of the societal challenges and accelerate the pace of these societal challenges.

Based on the assumptions used, the total estimated benefits amount to € 82.8 million per year for several years. These are one-off multi-year benefits that will gradually build up from 2023 onwards and continue to increase because the products, as a result of this investment, will be used effectively.

The estimated size of the investment is 41.6 million euros and the costs will depend on

[3] If the DTFL is able to provide outcomes or provide access to others through e.g. INSPIRE standards and European API requirements as in the High Value Data list, those opportunities are increased. In the coming years Europe will be working on a digital twin of the earth itself, particularly focused on climate adaptation, the environment and earth observation (see point 4, appendix 7), which underlines the importance of using the DTFL to meet European agreements on standards, APIs and data structures (such as INSPIRE).

the chosen pace of realization in the next five years. The costs for structural management & implementation for users are not part of this investment estimate. However, costs for connecting early adopters and central implementation costs are included.

On a macro-economic level, the National Digital Twins will yield more benefits than they require in investments. The benefit lies in the accelerated acquisition of insight into the choices for solving common tasks. By sharing and applying this knowledge, obvious benefits are realized. In that process, knowledge about the use of a DTFL is shared and enriched by working together. A solution for a location or issue can be reused or fitted into other locations and issues. By working together (sharing knowledge and DTFL tools) research and preparation costs need only be incurred once, saving time and money. These benefits have been incorporated into our cost-benefit analysis.

The financing of the investments involved in creating a National DTFL will be considered in conjunction with other intended investments in digitization related to the living environment. These include the expansion of the National Geographic Information Infrastructure and the system of key geo-registers. The investment proposal includes costs for the development and scaling up of use, and partly for the initial implementation by users and structural management.

Government initiative

The National DTFL optimally supports collaboration and knowledge sharing. In order to realize this on a national scale, government initiative is necessary. A National infrastructure must enable the development and use of digital twins on a broad scale and at different scale levels (neighborhood, planning area, region, national) and be designed on the basis of public values.

National because digital twins are now emerging in cities, but many issues also occur in the urban periphery or the countryside. There is no local support for developing digital twins there. In addition, the national government has an explicit task in National Spatial Planning. It is the right party to develop a national infrastructure, precisely because it represents the public interest and has the possibility to shape the framework and technology in a federated form on the basis of public values.

The National DTFL will ultimately be the success of cooperation of all sectors, providing a powerful facility for all. The National DTFL is of national infrastructural importance. This infrastructure forms an ecosystem for digital twins that are interconnected and use the same public and private data.

Governance

In this investment proposal for Governance (steering & deciding) we make a distinction between steering & deciding on:

- The investment proposal

- The National DTFL realization program
- The content within Field Labs and
- Management and use of National DTFL

Management and decision-making about the development and financing of the investment proposal is in the hands of the policy-making ministry and the National DTFL steering committee that has been set up.

The design for the governance of the National DTFL realization program will be made in consultation with the interested and participating organizations. This Governance will focus on establishing and scaling up the National DTFL

The organization of the governance within the Field Labs belongs to the initiators of these Field Labs in consultation with the authorities responsible for social tasks. By means of a letter of intent and later an implementation agreement, the rules of the game are named and secured on the basis of the goals of the National DTFL. These rules aim to actively apply and help formulate public values, actively share knowledge and reuse sources.

The Governance for the management and use of the National DTFL will first be further developed with the intended user groups and administrators in the phase of (preparation for) scaling up. This preferably takes place through the usual forums that exist for this purpose.