



DIGITALSTADT
DARMSTADT

WHITE BOOK SMART CITY

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DIGITALSTADT
DARMSTADT

WHITE BOOK SMART CITY

FOREWORD

12 June 2017: A milestone was set on this day – the city of Darmstadt was awarded the title of ‘Digital City.’ The BITKOM prize was an award and confirmation of how Darmstadt had already developed into a showcase smart city by virtue of its history and starting position.

So it’s no coincidence that we have been awarded the title by the IT industry association and the German Association of Towns and Municipalities. It is the result of years of thought and preparation. The development and promotion of electrical engineering is the cradle of digitalisation in Darmstadt: A proud heritage that is constantly being developed by a unique IT cluster.

The winning of the BITKOM competition and the launch of our initiative represent an intensification of this development. The state of Hesse was an important pillar and a valuable supporter as we embarked on our journey into the digital future. I would like to express my heartfelt thanks for this and, in particular, I appreciate the partnership and ongoing cooperation. Thanks to the 5 million euros in funding from the state of Hesse, we have continued to develop digitalisation over the past five years and tried out the future. We have broken new ground, especially with our aim of contributing to a European counter-model to the US digitalisation strategies based on privatisation and capitalisation and, above all, to the digitalisation strategies of totalitarian systems that rely on control and surveillance – with ethical guidelines that place data protection and data sovereignty as the highest priorities.



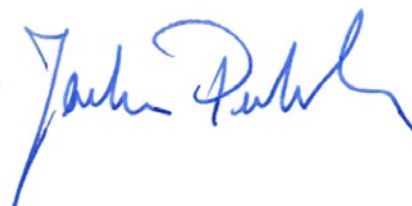
Darmstadt is a smart city that provides examples of how digitalisation can solve the challenges of a modern city. For us, the Smart City is an integrated aspect of sustainable and ecological urban development. From the environment, energy, mobility and the establishment of a data platform to administration, trade/tourism and cybersecurity to education, society and culture, almost all fields of service of general interest are covered. The diversity of the fields of action shows that smart city development is an interdisciplinary and cross-organisational project. Citizenship, which we involve in the further development of infrastructure projects, also plays a major role here. The opposition and criticism we have experienced have been valuable to us and have ultimately helped us evaluate our ambitions and approaches. Transformation processes can only succeed together with external experts, partners from science and research, internationally active companies and a forward-looking and cosmopolitan citizenry.

As a pioneer of this development in Germany, we have always understood our responsibility as a model city to mean that we share our knowledge

with the public. The knowledge we have acquired is intended to help other cities on their path to digitalisation. This White Book, which was produced by an independent team of consultants, is a valuable aid in this regard. It focuses on the philosophy and dimensions of a smart city, highlights four selected projects and offers recommendations for action based on the results.

Benefit from our experience, read it and feel free to contact Digitalstadt Darmstadt GmbH if you have any questions or feedback.

With warmest regards,



Jochen Partsch
Mayor of Science City Darmstadt

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1 DIGITALSTADT DARMSTADT – EXPERIENCES OF A PIONEERING CITY

Digitalstadt Darmstadt is considered one of the pioneering cities of digitalisation in Germany. This applies in general, but especially in the field of medium-sized cities. Development in Darmstadt was recognised and accelerated by winning the Bitkom ‘Digital City’ competition in 2017.

Since then, Darmstadt’s success has been demonstrated by consistently strong ratings in digital and smart city rankings such as the Bitkom Smart City Index, which ranked Darmstadt amongst the top ten cities in the German state of Hesse as the best municipality and the only medium-sized city in Germany.

The role of ‘pathfinder’ can also be seen in the fact that the state of Hesse and the newly established Hessian State Chancellery of the Minister for Digital Strategy and Development (HMinD) have deliberately established and promoted Darmstadt as an ‘experimental space for digitalisation.’

Darmstadt is a showcase of digitalisation for other municipalities in Hesse and beyond. After winning the title of ‘Digital City’, the state of

Hesse generously sponsored Digitalstadt Darmstadt. These funds were invested in 20 very different digitalisation projects. The experiences gained here have, for example, been incorporated into the state’s new digital strategy.

After four years, Digitalstadt Darmstadt GmbH (DDG) commissioned Die Strategiemanufaktur and e-hoch-3 to evaluate the projects funded by the state of Hesse. The projects were evaluated in a multi-stage process.

The results form the basis for the White Book Smart City. They are factored into the current smart city discussion, evaluated again and condensed in order to derive indications and recommendations for future work.

These are supplemented by good practice examples from Digitalstadt Darmstadt as learning cases for other municipalities on the road to becoming a smart city. In this way, a design and control perspective is derived from the ex-post perspective of evaluation.

THE PROCEDURE CAN BE DESCRIBED IN FIVE STEPS:

- 1 Selection of projects
- 2 Evaluation of projects
- 3 Development of smart city indicators
- 4 White Book with recommended actions
- 5 Guidelines for project (self-)evaluation



WHITE BOOK – OVERVIEW

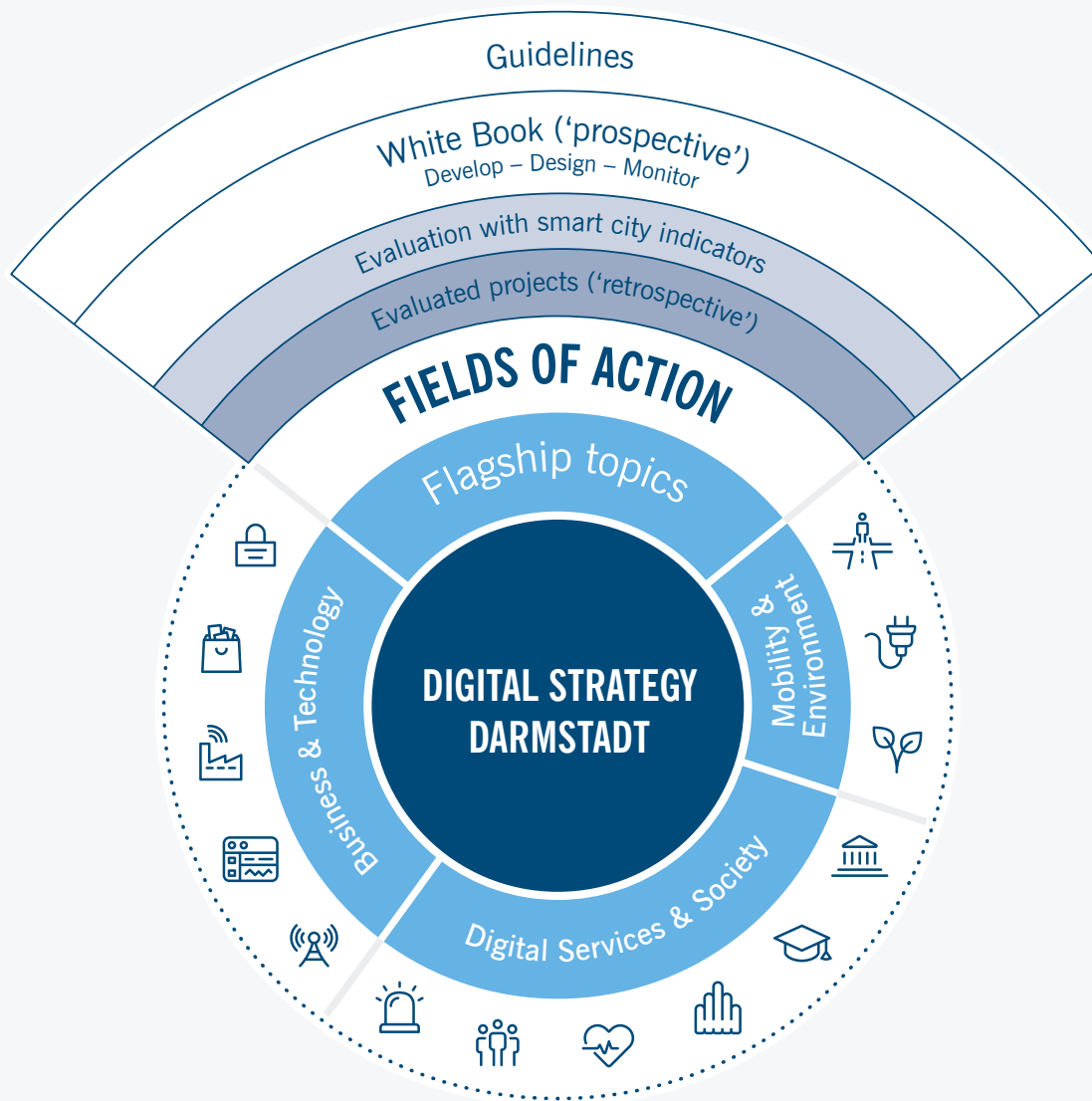


Fig. 1: Procedure for evaluating Digitalstadt Darmstadt projects and link to White Book with guidelines, own presentation (Die Strategiemanufaktur/e-hoch-3)

Digitalstadt Darmstadt had a classic starting point in the digitalisation of municipalities. The driving forces were a small group of people who wanted to secure the future viability of the city together. These included the leaders of the city and municipal companies, experts from administration, science and business, as well as representatives of the chambers that spearheaded development.

After Darmstadt's success at the Bitkom competition, the city established Digitalstadt Darmstadt

GmbH as a coordination and control unit for the numerous projects. Its structure is characterised by the close integration of the city, the city administration and the city economy.

An Ethics and Technology Advisory Board was also set up early, which adopted ethical guidelines for the work of the smart city in 2019. In terms of content, the nine points in particular focus on the aspect of the common good (1st guideline) and sustainability (2nd guideline).

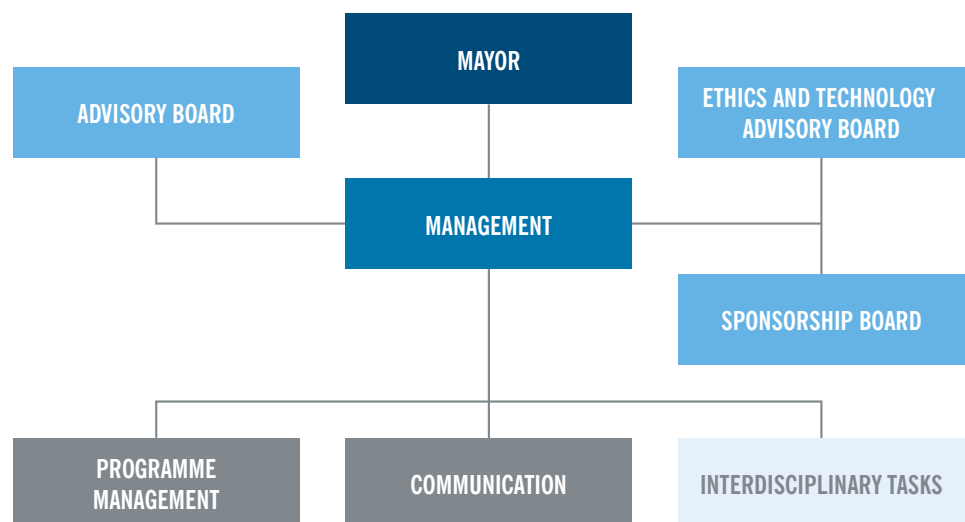


Fig. 2: Structure of DDG (source: Smart City strategy)

With the establishment of Digitalstadt Darmstadt GmbH, Darmstadt soon established the model of ‘external’ management of the Smart City activities, in which the management was not located within the administration. However, DDG represented a hybrid form of organisation at the management level, as the managing directors sometimes performed a dual function and interlinked the external limited company with the city administration and the city economy. This was a first structural step that tended to promote a holistic and networked view of the projects.

One consequence of winning the Smart City competition was the creation of a strategy for Digitalstadt Darmstadt. The order of ‘strategy comes after projects’ is a widespread pattern that naturally results from the arcs of the actors and the progress of digitalisation. The individual offices of the city administration and individual companies in the city economy follow current trends or are recruited by

companies for specific digitalisation projects. In this sense, digitalisation is often a bottom-up process that does not follow a pre-existing strategic master plan. This may lead to largely random and uncoordinated developments.

With its three lighthouse themes (Mobility and Environment, Digital Services and Society, Economy and Technology), five core objectives (secure, sustainable, forward-looking, participatory, valuable for us) and 14 fields of action (Mobility, Energy, Environment, Administration, Education, Culture, Health, Society, Security and Civil Protection, IT Infrastructure, Data Platform, Industry 4.0, Trade and Tourism, Cybersecurity), the Smart City strategy has a very comprehensive and qualitative approach (see the diagram on the strategy overview).

2 THE DIGITAL PROJECTS OF DIGITALSTADT DARMSTADT

From the perspective of the Hessian state government, Digitalstadt Darmstadt is a beacon of digital development in Hesse. After having been recognised as a smart city, this development was specifically promoted by the state and the smart city was seen as a space for experimentation without major restrictions or requirements. The heterogeneity of the 20 projects supported by the state is an expression of this freedom and the range of possibilities to test new approaches.

Procedures, products and business models developed in Darmstadt are intended to serve as

a source of inspiration and can be taken up by other municipalities. Darmstadt is thus a showcase and ‘role model’ of development for smart cities and regions in Hesse.

One element of this architecture is the exemplary evaluation of digital projects, the procedures and results of which are explained below, as well as the recommendations for action and the easy-to-use and practical guidelines for the (self-)evaluation of smart city projects.

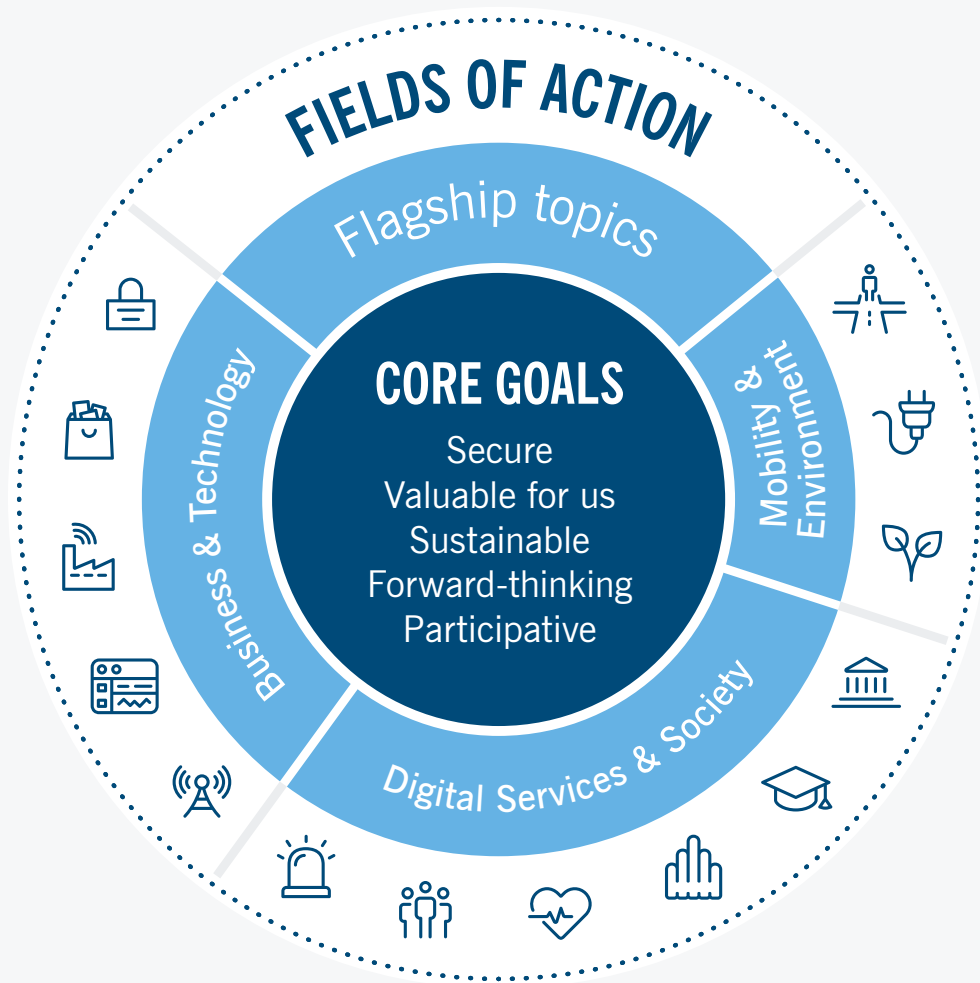


Fig. 3: Figure: Digitalstadt Darmstadt – strategy overview
 (Source: Smart City strategy)

2.1 PROJECT SELECTION

In the context of the objectives, projects were selected that ensure the greatest suitability for the transferability of the evaluation to other projects within the framework of Digitalstadt Darmstadt and beyond. The basis for the selection was an overview of all 20 projects including a brief project description, the respective field of action defined

by Digitalstadt Darmstadt, the thematic location (technological or social project) as well as information on the budget, duration, data basis, implementation period and partners involved in the projects. The project selection shown in Figure 4 was made on the basis of the aforementioned selection criteria.

THE DEFINED CRITERIA GRID



The digital strategy of Digitalstadt Darmstadt includes three lighthouse themes, five core objectives and 14 fields of action. The projects to be evaluated were selected on the basis of a systematic analysis of 20 projects funded by the State of Hesse in Digitalstadt Darmstadt and based on a predefined criteria grid, which includes the following selection criteria:

- 1 Representativeness in terms of technological, social and social dimensions
- 2 Transferability to current and future projects
- 3 Adequate data basis for evaluation
- 4 Differentiated project size (selection of both large and small projects)
- 5 Projects in different implementation phases (selection of both ongoing and completed projects)

Overview of state projects

- Haus der digitalen Medienbildung
- School projects
- Digital Education Pathfinder
- Smart City Laboratory in Darmstadt
- Digital for Everyone
- Expansion of environmental sensor network
- Public Wi-Fi in buses and trains
- Quality management in traffic light systems
- Digital Darmstadt Shop (new digital tourist information)
- Multimedia strategy for retail and tourism
- Digital Shop Window
- GovBot 'MathilDA' – digital citizen communication
- Data Platform
- Smart Waste
- Stay Vigilant, Darmstadt
- Smart Zoo
- Drones for the fire brigade
- Smart Lighting

Selection criteria

- Representativeness (technological and societal / social dimension)
- Transferability
- Sufficient data
- Large and small projects
- Different phases

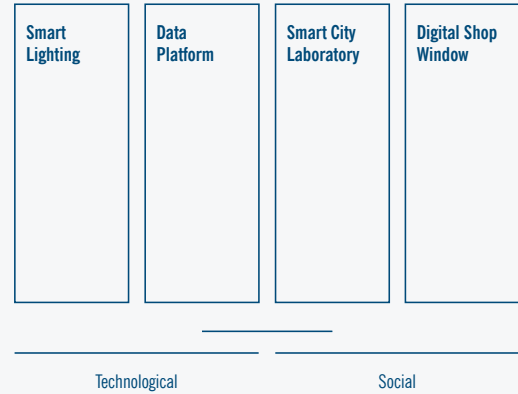


Fig. 4: Project selection using selection criteria, own presentation (Die Strategiemanufaktur/e-hoch-3)

2.2 EXEMPLARY EVALUATION OF PROJECTS

Four projects were then examined for the evaluation: the Digital Shop Window, Smart Lighting, the Smart City Laboratory and the Digital Data Platform.

The **Digital Shop Window** is intended to contribute to the promotion of a sustainable economic structure, the reduction of private transport and the provision of information to the public.

Economic objectives are to strengthen inner-city retail and catering as well as marketing and promote the image of the location. The environmental objective is to avoid private transport. Social objectives are quality of life and barrier-free accessibility of services. The public service obligation, non-discriminatory and barrier-free access, sovereign citizenship and data protection are central concerns.

Since 2019, the Digital Shop Window has been a central platform for the city of Darmstadt to present gastronomy and retail. In December 2021, around 550 stores were listed on the website. A partnership with LieferradDA enables goods to be delivered by electric cargo bike. Participants include the Darmstadt retail sector, Darmstadt Citymarketing e.V., Darmstadt Marketing GmbH with technical and editorial support, delivery service providers, Darmstadt University of Applied Sciences, the Citizens' Panel, LieferradDA and the Darmstadt Chamber of Industry and Commerce.

The **data platform** is intended to provide the public in Darmstadt with up-to-date environmental and traffic data, information on the COVID-19 situation, weather data and information on events. The data platform is intended to facilitate networking and communication between citizens, business and the city.

The platform is intended to ensure maximum data security through strong encryption and be a connecting element in Digitalstadt Darmstadt. Its own technical infrastructure is intended to ensure that any data generated remains under the sovereignty of the city and its citizens. In addition to the publicly accessible platform, there is a much more extensive internal administrative management dashboard that is accessible only to employees and the city's CIO.

Economic objectives are the promotion of business and cooperation, a sustainable economic structure, location marketing, business establishment and business start-ups. Ecological objectives include climate-friendly urban development and mobility, air pollution control, reduction of energy consumption, increased energy efficiency and the use of renewable energies. Social objectives are people's participation, cohesion, health, quality of life and safety.

Participants include the Environment & Mobility Office and the Office for Digitalisation and IT of Darmstadt, city-owned companies (EAD, HEAG, ENTEGA, Eigenbetrieb Bäder, Count & Care Darmstadt) and in future also the Office for Economic Affairs and Urban Development.

The design and call for tenders ran from late 2018 to late 2019, with implementation taking place in 2020. The platform has been available to the public since February 2021.

The aim of the **Smart City Laboratory** is to network stakeholders and citizens, promote constructive discourse, facilitate support in imparting knowledge and skills, and offer a platform for the co-creative exchange of ideas on existing projects and for new proprietary projects. It is intended to be both a physical and a virtual experimentation space for digitalisation topics. Participants include Science City Darmstadt, Akademie 55+ Darmstadt e. V., Chaos Computer Club Darmstadt e. V., Digitalstadt Darmstadt – fields of Culture, Society, Education and Cybersecurity, Digitale Darmstadt e. V., Digitalstadt Darmstadt GmbH, the European Space Agency, the Fraunhofer Institute for Computer Graphics Research IGD, the Fraunhofer Institute for Structural Durability and System Reliability LBF, the Fraunhofer Institute for Secure Information Technology SIT, Haus der digitalen Medienbildung, Hessisches Landesmuseum, Darmstadt University of Applied Sciences, Hub31 Technologie- und

Gründerzentrum Darmstadt, the Darmstadt Chamber of Industry and Commerce, the special interest group for elderly people in Darmstadt 'Interessenvertretung für ältere Menschen', Kultur einer Digitalstadt e. V., the Kunstforum museum of the Technical University of Darmstadt, Lab3 e. V., Merck Real Estate GmbH, the Schader Foundation, the Technical University of Darmstadt, T-Systems International GmbH and the community education centre vhs Darmstadt.

The aim of the **Smart Lighting** project is to establish a technical sensor infrastructure that can be used for smart city applications. The situational lighting control system should identify energy-saving potential and regulate the lighting as needed. As such, the project should also contribute to avoiding light pollution and protect animals and nature at night.

The data obtained from the sensors should also help to adjust traffic light circuits according to traffic volume and air quality. The situation-appropriate illumination of dark areas should contribute to an increased feeling of safety. Participants included the city of Darmstadt, e-netz Südhessen, ENTEGA as the operator of the network, the Smart City Factory and Vodafone AG.

The project ran from the start to the end of 2019 and is now complete.

2.3 ASSESSMENT USING INDICATORS

During the evaluation of the projects, the following indicators emerged as central to the evaluation of digital projects:

SDG contribution

The SDG contribution indicator, defined by the identification of sustainability contributions, is met by all four projects. Positive contributions to at least three SDGs and their sub-goals were identified for each of the four projects.

Both technological projects (Data Platform and Smart Lighting) focus on sustainability in the areas of innovation (SDG 9) and sustainable cities (SDG 11). In addition, both projects contribute to climate action (SDG 13) and environmental and species conservation (SDG 12 and SDG 15), although the specific focus of the projects varies. In comparison, the social projects (Digital Shop Window, Smart City Laboratory) differ significantly in their contribution to sustainability, with a common focus on inclusion and the reduction of inequalities (SDG 10).

The sustainability contributions of each project result in sustainability priorities (sustainability contribution by at least two of the four selected funding projects). Three of the four selected projects contribute to building a resilient infrastructure that promotes widespread and sustainable industrialisation and supports innovation (SDG 9).

The two funding projects with a social focus contribute to reducing inequality within and between countries (SDG 10).

The two funding projects with a technological focus contribute to the design of inclusive, safe, resilient and sustainable cities and settlements (SDG 11). Three of the four selected projects contribute to taking immediate action to combat climate change and its impacts (SDG 13).

With regard to their own monitoring during project implementation and for subsequent (self-)evaluation, it is generally advisable for projects to specify contributions to sustainability in the project planning phase. Extensive sets of indicators for the sustainability contributions of projects are available in reference works, which are suitable for project design.

Smart city potential

The smart city potential indicator with the above dimensions is met in three out of four projects. For the Digital Shop Window, the potential of the smart city is partly fulfilled. Close relationships and networking between the projects and the areas of Digitalstadt Darmstadt can be seen between the Data Platform and Smart Lighting projects in particular. The Smart City Laboratory also makes a major contribution to networking the areas and stakeholders in the smart city.

In comparison, the Digital Shop Window has less potential, as it is currently used purely as an information and commercial platform.

In order to be able to talk about smart city projects in principle, all areas must be closely linked and the data and insights gained from the projects must be examined, used and transferred to other areas. The high potential of the selected projects could be transferred to innovative applications and/or the extension of existing applications, thus creating added value for the entire city.

Degree of participation

The indicator for the degree of participation, defined by the involvement of business, academia, administration and civil society, is fulfilled in the Smart City Laboratory and Data Platform projects and is particularly pronounced compared to the other selected Digitalstadt Darmstadt projects. Both projects involve actors from different areas of urban society, and the citizens were able to actively contribute ideas.

The indicator is partially met for the Digital Shop Window and poorly met for Smart Lighting. The Digital Shop Window was initiated by Citymarketing, supported by the Chamber of Industry and Commerce, and primarily involved the retail sector as the target group for the project. Apart from the stakeholders from the business sector, the Smart Lighting project did not involve any potential users.

Dialogue with target groups

The social projects meet the indicator for dialogue with target groups, whereas Data Platform only partially meets the indicator and Smart Lighting hardly meets the indicator. Both the Digital Shop Window and the Smart City Laboratory attach great importance to involving stakeholders in projects and ensuring a lively exchange of ideas with each other. Through citizen participation, citizens can participate in the design of the public platform. In the case of Smart Lighting, there was no information on a comparable dialogue.

Data security

The data security indicator, defined by the security policy and monitoring (encryption, separation and regular audits, GDPR-compliant storage), could only be considered in the technology projects due to the weak data base of the Digital Shop Window and Smart City Laboratory projects. The indicator is met for the Data Platform project. In Smart Lighting, too, special software ensures high data security by focusing on sensor data and non-personal data.

Data quality

The cross-sectoral indicator of data quality – defined by the relevance, reliability and transparency of the data and information provided – was considered in the projects with a technological focus. The indicator is met both in the Data Platform and Smart Lighting projects. The up-to-date transmission and provision of the collected data ensures that the data provided is up-to-date, valid and transparent.

Sustainable use of data

Sustainable use of data – defined by the use of data in areas of sustainable urban design, such as traffic management – in social projects takes place within the framework of sub-projects of the Smart City Laboratory or, in the case of goods delivered by LieferradDA, via the Digital Shop Window only in a broad sense.

Visibility

The visibility indicator – defined by the presence of a dedicated website and a social media presence, the recording of the number of visits to the website, the number of links via other websites etc. – is partially met in three out of four projects. Smart Lighting does not meet this requirement, as there is no separate project website apart from the project presentation on the DDG website. Only the data platform has its own website. The Digital Shop Window can be accessed via the website of Darmstadt Citymarketing e.V., while the Smart City Laboratory can be accessed via the Digitalstadt Darmstadt website. Smart lighting is only described on the website of Digitalstadt Darmstadt.

Barrier-free website

The website accessibility indicator is poorly met in all projects. None of the four selected projects has a website that provides equal access for people with disabilities thanks to simple language and translation options.

In order to reach broader urban society with each service and to contribute to the inclusive focus of the digitalisation strategy of the city of Darmstadt (the core objectives being: valuable for us and participatory), accessibility is very important.

Degree of target achievement

The indicator for project target achievement consists of the experts' assessment on a scale of 1–5 (1 = low, 5 = high) and the comparison with the stated project objectives.

The degree of target achievement indicator is met in three out of four projects. In addition to Data Platform, both social projects achieved the goals set. Smart Lighting has not yet fully tapped its potential.

Project management

The indicator for project management – defined by the continuity of staffing – is met in the social projects. On the other hand, it is poorly fulfilled in projects with a technological focus. Up to now, there has been no change of project management in the two social projects, whereas the technological projects have experienced repeated changes of project management.

A detailed description of the projects, project evaluation and project indicators can be found in the long version of the White Book (chapter 3).

3 SMART CITY DEFINITION AND SMART CITY TAXONOMY

The shortest definition of a smart city is: A smart city is a connected city. Networking is understood here in several ways: economic-technological, social-societal, ecological-sustainable, institutional-organisational and as a network of business, science, administration and (civil) society. In all these dimensions, digitalisation is the key element. Only the intelligent linking of data makes it possible to control a smart city in a timely and strategic manner.

Digitalisation makes it possible to systematically control the complexity of a city via data streams.

For the first time, this will also allow the city to be systemically structured and controlled. In connection with the evaluation of the Smarter City Karlsruhe projects (2014), five dimensions of innovation for smart cities were developed (see illustration): (1) the technological-economic dimension, (2) the social-societal dimension, (3) the institutional-organisational dimension, (4) the sustainable-ecological dimension and (5) the participatory or ‘co-dimension’ (human-centred). These five perspectives enable a systemic shaping of the quality of life for the people of a city or region.

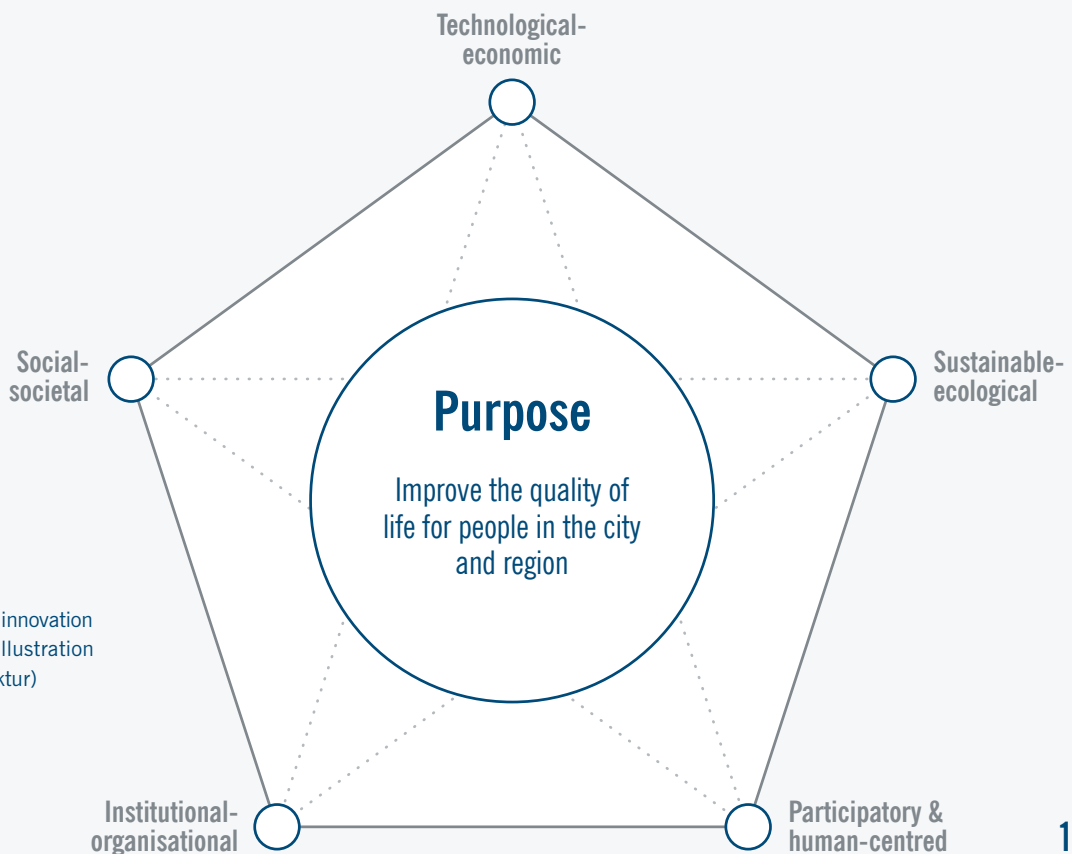


Fig. 5: Dimensions of innovation of a smart city, own illustration (Die Strategie-manufaktur)

This definition of smart cities links up previous lines of definition and debate in the digital city and smart city discussions, integrates them and adds two dimensions of 'how' to the three content-related dimensions of the 'what', which have so far been insufficiently accounted for as success factors. At its core, it is always about an institutional innovation in order to become a smart city.

The working methods of organisations also significantly influence the outcome of content and play a key role in the consolidation of new approaches. The effective implementation of project results therefore requires a critical review of the current organisational design. This involves the further development of existing structures and the re-wiring of the individual organisational units both internally and externally.

The first example of a comprehensive administrative modernisation in the context of the smart city is the thematic scope or IQ solution developed by Die Strategiemanufaktur for the city of Karlsruhe in 2014 and now implemented, an expanded matrix organisation coupled with a city-wide innovation team that represents the link between key issues within the administration and serves as a radar for future issues.

The growing importance of this dimension is reflected in a number of recent debates and reports, including a new report to the Club of Rome, which addresses the issue of 'structural silos' and speaks of the fragmentation of knowledge, administration and accountability as a crucial barrier to transfer. The founding of the New Institute in Hamburg also tries to focus more on these systemic relationships.

FROM SMARTER CITY KARLSRUHE TO THE IQ PROCESS

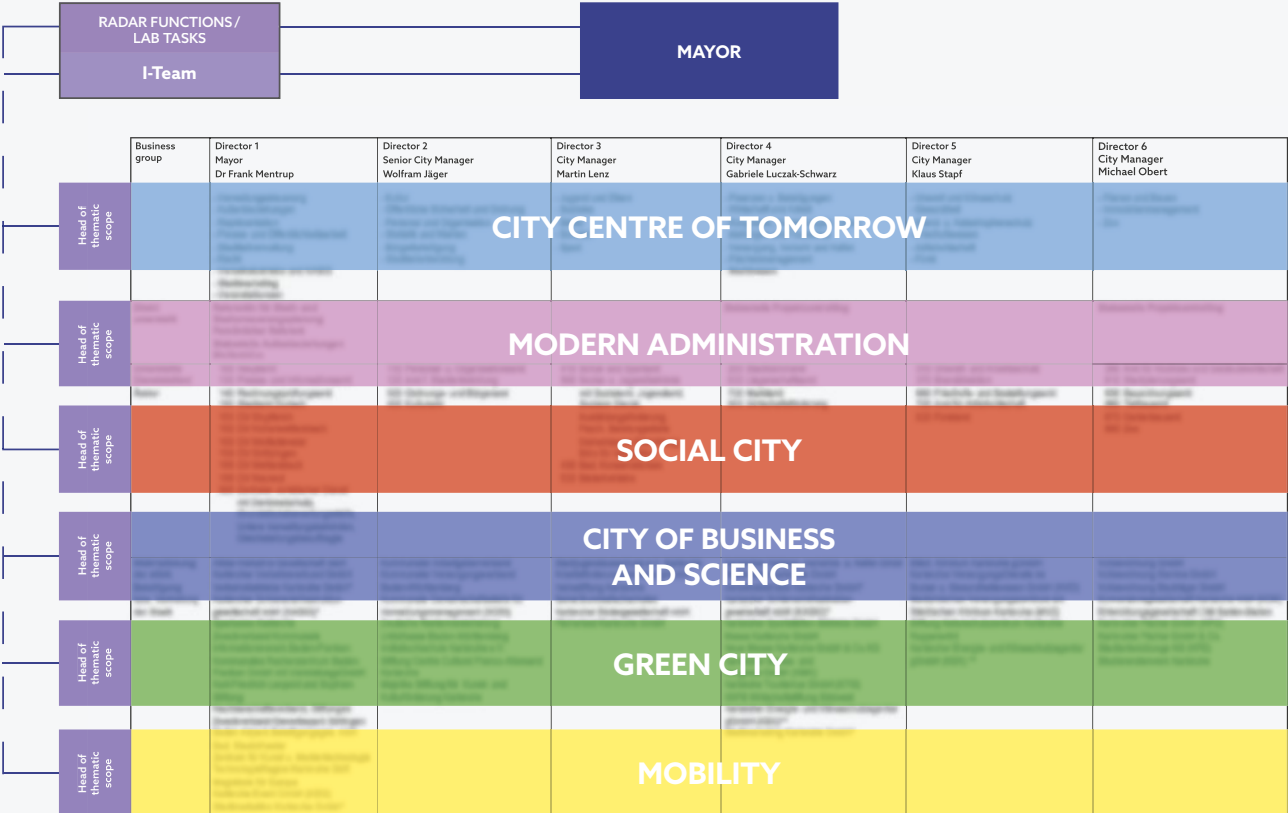


Fig. 6: Institutional innovation of a smart city using the city of Karlsruhe as an example, own presentation (Die Strategiemanufaktur)

The development of smart city taxonomy is based on three lines of development. This is firstly the general discussion on evaluation, monitoring and impact-oriented management, secondly the development of 'major indicator sets' and thirdly the state of the general discussion in the context of smart city development.

This general discourse also forms the background for the 'bottom-up approach' of evaluation developed during the evaluation of Digitalstadt Darmstadt projects. Here, the indicators were developed from the projects and arranged according to the smart city definition.

The continuously increasing availability of all types of data (mobility data, sensor data, open government data etc.) and the possibility of linking them via platforms such as the Darmstadt Data Platform are opening up completely new control possibilities, the development of new business models and digital solutions for a liveable and climate-neutral city. Classification systems that bring together, relate and define these different aspects, concepts and dimensions are referred to as taxonomies. A specific smart city taxonomy must take into account the interconnected, content-related, organisational and participatory multidimensionality.

The taxonomy developed and used here, based on the systemic smart city approach developed by Die Strategiemanufaktur, creates both an analytical framework for smart city projects and a control framework for the future. This taxonomy also enables good application in practice and can be differentiated as desired from the easy-to-use basic model of the guidelines in a kind of 'slider principle', as it can be expanded accordingly in the smart city dimensions using the existing KPI



FIVE (INNOVATION) DIMENSIONS OF A SMART CITY

- 1 Technological-economic dimension
- 2 Social-societal dimension
- 3 Institutional-organisational dimension
- 4 Sustainable-ecological dimension
- 5 Participatory or 'co-dimension' (human-centred)

systems (CITYkeys, OECD etc.). In the evaluation of Digitalstadt Darmstadt, a five-dimensional indicator was used according to the taxonomy.

This smart city taxonomy brings together the various discussion paths and dimensions, such as digitalisation, sustainability, participation and co-design, into a systemic overview of a smart city.

In addition, it adds the dimension of institutional and organisational innovation that smart city projects must generate if they are to be successful in the long term.

This holistic perspective on the smart city, smart city funding projects and their evaluation, as well as future monitoring, is new.

LEARNING CASE:

SMART CITY EXPERIMENTATION ROOM

Since winning the Bitkom competition, Digitalstadt Darmstadt has been regarded as a pioneer of digitalisation on the road to becoming a smart city. New paths require courage and the testing of possibilities, ideally in an experimental space that makes this possible.

Since 2018, Darmstadt has been an experimental space for digitalisation and smart cities with a total of 20 very different projects in order to make this experience available to other (Hessian) municipalities.

Learning: Digitalisation and smart cities require **areas of experience** and the **sharing of** pioneers' experiences with others in order to accelerate the pace of digitalisation and reduce investment costs through 're-use'.



4 RECOMMENDATIONS FOR ACTION

Numerous indicators were identified and evaluated from the evaluation of the digital projects funded by the state of Hesse, which in many places have links to smart cities (see also the explanations in section 2). These can also be used to evaluate other regional projects in Digitalstadt Darmstadt.

By placing them in the context of the current general debate and against the background of the knowledge of the challenges posed by sponsors, the following recommendations can be derived, which are divided into three levels:

- 1) Recommendations for action at the project level, the project partners and the project design
- 2) Recommendations for action at the level of municipalities and smart city ecosystems
- 3) Recommendations for action at the programme design level

The manuscript and recommendations for action were completed in May 2022. The recent developments in the funding landscape, e. g. in the context of the criteria in the Smart Cities Model Projects programme, confirm the recommendations.

The recommendations for action include exemplary developments and activities in the context of digitalisation as learning cases that are intended to encourage reuse and replication. They illustrate Darmstadt's experiences for others in terms of the experimental space of digitalisation, for which the state funds were intended, so that findings can be made available for other municipalities and that the evaluation, the White Book and the guidelines should make use of for other municipalities.

4.1 PROJECT LEVEL – PROJECT CONSORTIA – PROJECT DESIGN

The recommendations for action (RA) are aimed at optimising a smart city in the sense of a networked city and the resulting systemic perspective, which must be adopted by all actors and in all dimensions of the projects. This applies not only to the content of the project topic and the composition of the project consortia, but also to the retroactive effect on one's own working methods, the openness of the organisations, their internal processes and work routines.

With this networked view, it is also important to observe the following connecting lines between the levels of the recommended courses of action and the systemic view. The transitions are correspondingly fluid.

RA 1: Clearly describe objectives and metrics

For a comprehensible evaluation of projects, their objectives must be clearly and unambiguously described and correspondingly measurable indicators (KPIs) defined so that the achievement of objectives can be comprehended and evaluated. This also applies in the context of experimentation rooms, as they make it possible to learn from failure without risk.

Numerous sets of indicators are available for all five smart dimensions – technological-economic, social, ecological, participatory and organisational.

RA 2: Establish project monitoring

The establishment of a project monitoring system makes it easier to manage the project according to the defined key indicators. The monitoring can be further adjusted during the project so that it can be connected and used accordingly in regular operation when it is stable.

RA 3: Strengthen focus on effectiveness

Effectiveness in terms of improving the quality of life of a city or region in a way that is tangible and measurable for the people is the central objective of a funding project. This goes beyond the formal output-outcome orientation and is to be defined in the project proposals (see also the smart city guidelines in the appendix).

LEARNING CASE:

SMART WATER — DIGITALISATION AS A TOOL

The role of digitalisation in the age of the smart city is changing. While the digitalisation of municipalities was often the goal in itself during the first wave, this is now a phase in which digitalisation is seen as a tool. It's all about digitalisation 'without a screen or keyboard.' One example of this is the Smart Water model project in Darmstadt, which, as part of the 'Smart Cities made in Germany' model projects, addresses questions of the future use of water in the city, climate and sustainability with a focus on digitalisation.

Learning: The **next generation of digitalisation and a smart city are using digitalisation to solve future challenges** in the area of climate and city resilience, and not just to digitise the status quo as before.



RA 4: Carry out project screening

One of the key challenges in smart city projects and smart city funding is to avoid duplicate funding. For this reason, all projects should carry out appropriate screening in the future in order to identify comparable projects in advance and to sharpen their own innovation dimensions.

RA 5: Define climate neutrality as a core objective of the projects

The consideration of climate neutrality in smart city projects systematically links digitalisation and the topic of sustainability.

RA 6: Enable the consolidation and dissemination of project results

Funding is an investment in shaping the future, not a subsidy for the status quo. Consistent project results is a key contribution to the effectiveness of digital and smart city projects. This applies equally to individual product developments, business models or system solutions. Continuity does not follow after the project, but must basically be defined as the final phase of the project itself and created accordingly.

RA 7: Use participation for knowledge management and mobilisation

Participation and co-design through to co-production are key success factors in digital and smart city projects. The full range of citizen participation possibilities should be used in projects: as an element of open innovation, as a knowledge management tool, to increase reach and to mobilise urban society for effective project implementation. The establishment of smart city laboratories offers a sustainable basis for this.

RA 8: Develop project silos into project systems

A key feature of future projects should be their interconnected structure, which factors in the link to other smart city projects and initiatives in the city, thus taking into account the core feature of connectivity – both horizontally and vertically.

LEARNING CASE:

**OFFICE OF DIGITALSTADT
DARMSTADT GMBH**

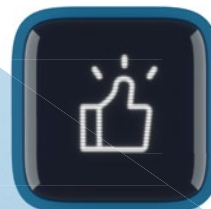
4.2 MUNICIPALITIES – SMART CITY LEVEL

RA 1: Define your own understanding of a smart city

The successful design of a smart city begins with the definition of one's own understanding of a smart city or digital city in terms of content and organisation. It offers clear guidance to all stakeholders in the multi-helix structure (administration, business, academia, civil society) and succinctly describes the purpose and effects of smart city and digital projects.

RA 2: Create an office in the space between

An independent – hybrid – office whose staff are linked to the different organisations of the smart city allows for the professional management of the various smart city and digital projects. It can perform various functions: Concentration of activities and resources, acceleration and motor functions and, centrally, a continuity function (knowledge and know-how storage) beyond the project term. Digitalstadt Darmstadt GmbH is a nationwide pioneer in this respect.



Digitalisation and a smart city are interconnected and can be effectively shaped by the cooperation of stakeholders within the city. Darmstadt has set standards here with DDG as the project office, because representatives of the city administration and the municipal utilities work together in independent management and, at the same time, continue to work in their 'posting organisation' – alongside a third full-time member of the management.

This new form of '**intermediate organisation**' prevents parallel procedures and duplication of work.

Learning: The best way to **manage and control smart city projects** is through innovative network structures that give smart city management its own freedom deliberately, without traditional integration into the line organisations, but also without completely breaking away from them.

RA 3: Establish an ethics advisory board and ethics guidelines

The technological and economic orientation of digital projects is key, but not sufficient on its own. The increasing debate over the fundamental ethical issues of digitalisation and artificial intelligence in recent years makes it necessary to systematically integrate this topic into the development of smart city projects. The early establishment of the Ethics and Technology Advisory Board and the adoption of the Ethics Guidelines in Darmstadt can serve as a model here.

RA 4: Chief storyteller – shaping a shared vision

A smart city requires a positive vision of the future that provides orientation and gives a sense of meaning to projects that, through their lifeless language, are often technological or digital in nature. Smart cities not only need a Chief Digital Officer, but in the future, as a narrative counterpart, the role of Chief Storyteller based on the Scandinavian model, who translates political goals into positive and vivid visions of the future that have a positive pull effect.

RA 5: Understand smart cities as ecosystems

Due to their nature as networks, smart cities are collective works of an inclusive urban society. They form an ecosystem of diverse actors. This ecosystem represents the potential of smart cities. It can be connected and used more easily and effectively thanks to new digital instruments and tools.

RA 6: Strengthen connectivity and relationship capital

A basic prerequisite for working in networks is the cooperation skills of the actors in the different sectors, an understanding of the perspectives of others and empathy in dealing with partners in the innovation ecosystem of the smart city or smart region. This cooperation skill is not only needed at the level of top management (C-level), but also, until now underestimated, at the working levels below in order to 'get the show on the road'. Therefore, the lack of relationship capital is a development barrier for smart cities as multi-helix systems, i. e. cross-sector cooperation. The relationship capital must be developed and increased by appropriate measures (e. g. Brainport Academy Eindhoven).



RA 7: Drive institutional innovations

A smart city as a networked city is not only developed through the content of the projects, but is only successful in the long term if the type of cooperation and the internal processes and structures of each organisation are aligned with one other. The organisational design must under-

stand and map the attitude and the transformation of the silo organisation into a systemic smart city. A key success factor here is the reorganisation of inter-agency and inter-departmental cooperation within the municipalities and the opening up of the administration to smart city ecosystems.

LEARNING CASE:

ETHICS AND TECHNOLOGY ADVISORY BOARD

For a long time, digitalisation in municipalities was a technological matter that had little or no place in the social and ethical context. This is changing significantly, as this perspective is an increasingly important success factor. The direct collaboration between technology and ethics experts on the advisory board enables the two perspectives to be combined from the very beginning.

This is why the Smart City established an interdisciplinary Ethics and Technology Advisory Board very early on, which adopted nine guidelines for digitalisation projects. These range from public service obligations, democratic control, data protection, transparency, data disclosure, city and citizen sovereignty and accessibility to sustainability and infrastructure security (cyber security).

Learning: The establishment of an ethics advisory board is a key success factor for consideration of the bigger picture and analysis, as well as for acceptance within urban society.

RA 8: Drive cultural change

Opening up to the outside world and strengthening cooperation 'across silos' requires a cultural change that takes place through concrete experiences in everyday life. For this reason, the way of working must be changed selectively but specifically by and within smart city projects. One specific approach is the work of the Smart City Laboratory. Another option is the establishment of so-called 'start-ups in residence', which bring a different working culture to life directly in administrative offices.

RA 9: Understand urban and civil society as an anchor of success

Citizen participation is a key success factor for smart city projects. The involvement up to the co-production of urban quality of life anchors technological and social innovations in urban society. It serves to manage acceptance and the necessary reach of projects within society in all its diversity, thus promoting effectiveness.

RA 10: Recognise and use time as a key success factor

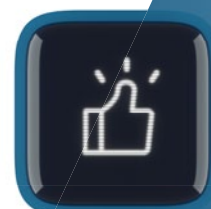
Projects that are thematically transdisciplinary, organisationally silo-spanning and cross-sectoral require learning time. These cannot be accelerated at will. They have to be 'priced in' when building a smart city in the sense of a connected city. If these seemingly decelerated phases are maintained, they will accelerate the speed of implementation even more.

RA 11: Drive the development of data platforms for control

'Cities are real time systems, but rarely run as such'. In future, the development of data platforms will enable the networked control of a city (environmental, traffic and mobility data, sensor cities, digital twins etc.) in real time. The digital data platform of Darmstadt is one of the pioneers in this field in Germany, especially with regard to the internal administrative areas of the project.

RA 12: Connect smart cities with interoperable data

As a sensor city, the smart city must be able to use its data across the board. Therefore, the interoperability of data is a crucial prerequisite for the development and management of the city without reducing data security.



LEARNING CASE:

SMART CITY LABORATORY

To be successful, a smart city needs the openness and involvement of key players from science, business and, above all, the urban society itself. This requires new tools and locations. The Smart City Laboratory is both a location – centralised, decentralised and digital – and an instrument for dialogue and openness. This is where new formats such as the Mobile City Laboratory, the Digital Learning Workshop and the participatory Environment/Water project are developed and tested.

A core team of representatives of the individual stakeholder groups, known as ‘architects’, together with a full-time coordinator, is the driving force behind the Smart City Laboratory and its activities.

Learning: A smart city requires an active urban society and places of dialogue. **The establishment of smart city laboratories creates these places and spaces for dialogue with the city’s society** and other relevant stakeholder groups and actors.

LEARNING CASE:

DIGITAL DATA PLATFORM

The digital data platform of Digitalstadt Darmstadt is one of the pioneers nationwide in the processing and visualisation of urban data. The data platform has a publicly accessible dashboard that enables citizens to access and monitor a wide range of up-to-date data – such as the latest environmental data including particulate matter pollution, ozone values for urban areas, traffic and public transport data, climate data and waste data. In addition to this data, citizens receive information on current cultural events. The excellent visual presentation of the data makes orientation easier. The data platform is a new communication channel for smart cities to communicate with their inhabitants.

The more comprehensive internal administrative data platform enables and facilitates the management of key services of general interest (e.g. waste collection) and urban infrastructure (e.g. dynamic traffic management).

Learning: The establishment of a digital data platform makes the use of data and the digitalisation of services of general interest visible to citizens, businesses and administrations, and brings municipalities closer to real-time data management.



RA 13: Strengthen sustainability through data minimisation

More digitalisation means more energy and resource consumption. Smart city projects themselves should therefore follow the principle of data sufficiency and generally contribute to increasing climate neutrality and resource efficiency.

RA 14: Usher in a new era of cooperation between administration and start-ups

The potential of cooperation between public administration and start-ups has not yet been fully exploited. Smart city projects can become a catalyst for innovation collaborations that give new impetus to digital services of general interest and involve start-ups in the municipal service delivery system.

This is where innovative impulses from start-ups, municipal economic development agencies and administration combine to create a new ecosystem of smart services of general interest.

One form is the ‘venture client approach’, in which the municipality essentially acts as ‘venture capital.’ As a first/premium customer, the municipality takes advantage of the start-up’s business idea. This cooperative relationship can also be thought of the other way around, similar to the ‘start-up in residence’ programmes, in which start-ups apply with their solution to a municipal challenge and the winners develop the solution together with the municipality.

4.3 LEVEL OF FUNDING PROVIDERS

The results described in the White Book apply not only to individual cities, but also to regions. In addition, there is great potential in inter-municipal cooperation, which is essentially opening up completely new possibilities as a result of digitalisation. It is necessary to shape digitalisation in a smart city or smart region over the previous territorial congestion, because they are inherently ‘trans-territorial’ or, as Rob van Gijzel, one of the founding fathers of the Brainport Eindhoven region, emphasises: Collaboration must be horizontal, inclusive and co-creative.

RA 1: Introduce smart city impact assessment

Funding applications should focus more on the interconnected nature of smart city projects from the outset. This can be done, for example, by introducing a smart city impact assessment as a prerequisite for funding and supplementing or adapting funding recommendations and criteria.

RA 2: Establish comprehensive smart city/ smart region monitoring

The issue of monitoring government resources and their impact is as central to the requirement as it is complex to implement, since Germany does not have the performance measurement tradition of Anglo-Saxon countries and does not have the corresponding acceptance in practice.

By establishing a nationwide and public digital or smart city/region monitoring system, project screening for applicants as well as the potential for the adoption (dissemination) of project results would be facilitated in addition to the political and administrative control potential.

RA 3: Build a Smart Region Virtual Office into a Smart Region Agency

With the bundling of central advisory and support activities in the Smart Region Virtual Office, which is managed by the Hessian Ministry of Digitalisation, the state is well positioned. The further development and consolidation of activities in a digital agency in Hesse and comparison with experiences in Brandenburg and Bavaria should be considered for a next step in development.

RA 4: Describe Smart City Ecosystems

Up to now, the funding of smart city and digitalisation projects has been heavily influenced by path dependencies in science, business, administration etc. The future lies more in a joint perspective. This requires a systemic overall picture and the funding of 'project associations' as a basis.

RA 5: Smart cities and smart regions: promote capacity building

The era of isolated lighthouses is drawing to a close. The challenges are complex, networked and 'wicked'. Solutions can only be achieved through transversal networks, across disciplines, sectors and administrative boundaries (between city and surrounding areas, use of inter-municipal centres etc.). Municipal or regional capacity building is required for smart cities and smart regions.

RA 6: Introduce a utilisation plan for project results as a prerequisite for funding

The dissemination and use of project results is one of the key challenges that is widely discussed under various keywords (including dissemination, replication, scalability and propagation).

The introduction of a plan for the utilisation of project results as part of the project application makes this point easier to discuss between sponsors and recipients.

RA 7: Smart city funding only awarded to consortia with lead and follower cities

The wider dissemination of project results and networking between municipalities can be promoted by introducing and further developing the 'lead and follower cities' approach, as project consortia significantly increase their reach and use is by definition strengthened.

This complements Darmstadt's 'showcase of digitalisation' approach, continues it and substantiates it through the cities' increased commitment in the context of funding.

RA 8: Include stability clause in subsidies

The frequent lack of consistency in project results is due not only to the fact that this transition is not sufficiently planned in the routine processes from the outset, or simply to the 'blind spot' of

the project partners, but also to a lack of incentive. Therefore, a certain percentage of the funding should remain blocked as a 'stability bonus' (e.g. 15% of the total funding).



LEARNING CASE: EVALUATION AND SHARING KNOWLEDGE

Digitalstadt Darmstadt is an experimentation space, a learning laboratory from which insights can be derived for the city itself and other municipalities. In order to systematically evaluate the experiences, DDG commissioned an evaluation, the results of which have been incorporated into a White Book Smart City, which is made available to other municipalities.

Another practical application from this is the guideline, which can be used to design smart city projects and self-evaluate smart city projects.

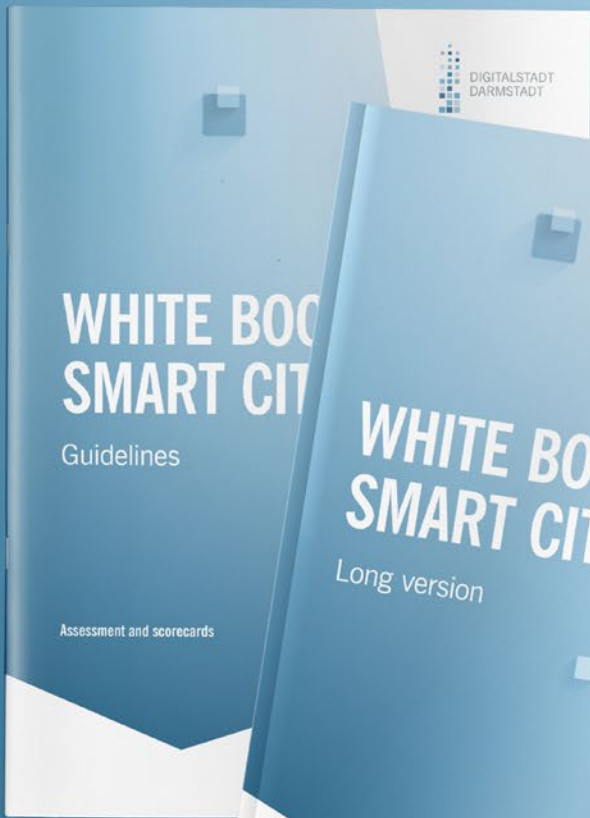
Learning: The **evaluation of digitalisation and smart city projects** is a key element of success. Sharing this knowledge and experience with other municipalities, e.g. by **developing easy-to-use guides**, promotes the shared learning of experiences between municipalities and creates a smart sea of lights instead of individual lighthouses.

WHITE BOOK SMART CITY



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